

# ION GNSS+2014 | SHOW DAILY

THURSDAY EDITION

From the editors of  
**InsideGNSS**  
GPS GALILEO GLONASS BEIDOU

## PROGRAM UPDATES

**EXHIBITOR DEMOS**  
Thursday, September 11  
Room 17

11:00 a.m. - 11:45 a.m.  
Spirent Federal Systems  
"The Newest in GNSS Simulation Technology - Spirent GSS 9000"

2:00 p.m. - 2:45 p.m.  
IFEN GmbH  
"Inside Spoofing"

**PROGRAM CHANGES**  
Thursday, September 11

Session C3a:  
Alternate # 3 by Y. Zhang,  
Withdrawn.

Session F3b:  
Paper #3 by D. Serant,  
Withdrawn. Replaced with  
Alt. #1 by J.W. Mitchell

Session A4:  
Paper # 3 by T. Reid,  
Withdrawn. Replaced with  
Alt. #1 by T. Kahn  
Paper #6 by D. Bhatt,  
Withdrawn. Replaced Alt.  
#2 by J. Fang

Session B4:  
Paper #3 by S. Frodge,  
Withdrawn. Replaced with  
Alt. #1 by S. Saito

Session C4:  
Paper #4 by D. Kubrak,  
Withdrawn. Replaced with  
Alt. #2 by B. Keyser  
Alt. #1 by M. Cuntz,  
withdrawn.  
Alt. #2 by M. Cohen,  
Withdrawn.

## European Proposals Could Interfere with GNSS

# Move to Allow L1 Pseudolites

Dee Ann Divis and Peter Gutierrez

Two European proposals to allow pseudolites in the protected frequencies used by GPS and Galileo could soon be adopted, creating a potential interference risk to GNSS receivers and hampering efforts to protect satellite navigation spectrum, experts say.

"The pseudolite systems that some people are thinking of around the world, we think are a real danger to GPS and GNSS reception and could be a danger to safety of life," Ray Clore, GNSS senior advisor at the U.S. State Department, told the audience at a meeting Tuesday of the Civil GPS Service Interface Committee in Tampa Florida. He said the subject would be discussed next week in Boston when U.S. and European representatives meet for regular bilateral talks on GNSS.

The proposals, one each for indoor and outdoor pseudolites, are working their way through the approval process of the European Conference of Postal and Telecommunications Administrations (CEPT), a body focused on communications issues that is some-

what similar to the U.S. Federal Communications Commission. A CEPT working group has completed a series of studies and devised regulatory frameworks for national governments to use to approve and manage pseudolites, ground-based devices that transmit GNSS-like signals.

The frameworks, which are issued by CEPT's Electronic Communications Committee (ECC), suggest pseudolites or PLs be allowed in the spectrum band from 1559-1610 MHz — the frequencies designated by international agreement for use by Aeronautical Radio Navigation Services (ARNS) and the Radio Navigation Satellite Services (RNSS). The RF band, centered at 1575.42 MHz, is used for GPS L1 C/A and Galileo E1 signals.

The European Geostationary Navigation Overlay Service (EGNOS) Space-based Augmentation System (SBAS), which supports Galileo system integrity and transmits differential corrections to GPS, uses the same center frequency as the L1 GNSS signals.

*Pseudolites continued on page 3*

## Europe Hopes to Rescue Satellites

# Launches Planned by Every GNSS Program

Dee Ann Divis

The European Space Agency will attempt to save two Galileo satellites placed into the wrong orbits August 22 during a launch mishap, European officials said Wednesday during a series of program updates at the ION GNSS+ 2014 conference.

"It is our intention to rescue this mission," said Marco Falcone, ESA's Galileo system manager.

The spacecraft, the fifth and sixth of the Galileo satellites to be launched — and the first of the fully operational capability (FOC) spacecraft — were placed into a highly elliptical orbit

*Systems Panel Update continued on page 7*

## NavtechGPS Open Mic Night Rocking the Bay



All ION GNSS+ 2014 attendees are invited to NavtechGPS's annual Open Mic Night, with live music, karaoke, dancing, and a door prize, Thursday, September 11 — 8 p.m. to midnight at the Tampa Marriott Waterside Hotel and Marina, 700 South Florida Avenue.

*Pseudolites continued from page 1*

The band is also specifically protected for safety-of-life applications, including aviation, and ARNS and RNSS are considered primary — that is, any other use of those frequencies is not supposed to create interference to the primary services.

But interference and spoofing are very much a possibility if pseudolites are allowed in the band, said Kirk Zimmerman, director of engineering at the receiver manufacturer Trimble and Michael Swiek, president of the GPS Innovation Alliance.

Speaking to the June meeting of the National Space-Based Positioning, Navigation, and Timing (PNT) Advisory Board, GNSS experts who advise the top levels of the U.S. government on technical and policy issues, Zimmerman and Swiek said the proposals were, in many ways, “based on incomplete or even flawed studies.” Input from the satnav community to the communications-focused CEPT had been largely “ignored discounted or rejected.”

“Usually when we talk about interference to GPS and GNSS signals, it's coming in a direction or from a forum where we have some familiarity with what's going on,” said Swiek. “This is a bit of an unusual story, it's a little more complicated, and something we really haven't seen before. This regulatory proposal is actually coming largely from outside of the satnav community either here or in Europe. It's moving forward in for a where the satnav communities usually don't play a role and really haven't had much input.”

Swiek and Zimmerman pointed out that ECC reports acknowledged the risk of interference. For example, the framework for the indoor PLs said that before pseudolites could be installed at or near airports a case-by-case analysis needed to take place to assess the interference risk. The framework report for outdoor pseudolites said they should not be installed at or near airports. It also said that no-fly zones should be considered for areas where outdoor pseudolites were in use.

Despite the clear potential for interfer-

ence, ECC Reports 145 and 183, which summarize studies on the issue, assert that the 1559–1610 MHz band can be used for indoor and outdoor pseudolites. In fact, the ECC has recommended its framework for indoor pseudolites (report ECC Rec (11)08) which, according to the European Communications Office website, four countries have either adopted or committed to and five are studying. Seven nations have decided not to adopt it, and no information is available about the decisions of another 32 countries.

“Since the ECC Recommendation (11)08 is also included in the European Common Allocation Table (ECA, -> ERC Report 25), one can assume that many administrations in Europe will implement, either on request from the market or automatically,” said Thomas Weber, spectrum management expert at the European Communications Office, which supports CEPT.

Weber told *Inside GNSS* that Space Systems Finland other pseudolites manufacturers were advocating for the proposals.

The indoor PLs could be used to support indoor production lines, receiver testing, and the movement of equipment in enclosed areas like hangers. They could aid navigation in auto tunnels or help people walking through museums and airports. Potential security and military uses and mass market consumer applications include using PLs to cover indoor retail environments, according to ECC Reports 145 and 168.

Outdoor PLs, as described in ECC Report 183, could be employed for improving signal coverage in cities with tall buildings, the ECC says in Report 183, as well as for positioning goods and vehicles. Possible maritime applications include at harbors as well as applications locating containers in large warehouse areas, providing infrastructure protection and machine control at open mining sites, and doing terrestrial deformation monitoring.

It does not appear that a framework rec-

*Pseudolites continued on page 4*

**Pseudolites** *continued from page 3*

ommendation has been made for outdoor PLs.

If implemented, the two proposals would be exceptions to the global agreements that protect the ARNS/RNSS band, creating cracks in the wall that shields satellite navigation applications from communications firms and other users who have tried repeatedly to get access to GNSS frequencies.

“If adopted, Swiek said, “these regulatory proposals will establish some really worrisome precedents. . . . It would give us some unallocated ground radio transmitters directly in our band. Not a good idea.”

Zimmerman and Swiek pointed out that the wording of the ECC reports suggested other incompatible, in-band transmitters might also be allowed.

A decision point on the PL proposals arrives in 2015, which in terms of regula-

tory years, Swiek said, “is really just around the corner.”

A source following the issue, who asked not to be named, asserted that the European Telecommunications Standards Institute (ETSI) is developing a draft GNSS product standard for CEPT that covers both indoor and outdoor PLs. The source believes the target timeline would have the standards completed next year.

ECC report 183 does say that ETSI had “been requested to develop in the near future a harmonized standard for Outside PLs.”

The GPS Innovation Alliance said “its members have been following regulatory developments in Europe, including the possible commercial licensing of in-band pseudolite, and are

working with key stakeholders to ensure that potential interference issues are well understood and addressed.”

Weber indicated that any interference would be addressed. The “ECC takes all reports about jamming, spoofing or disturbing GNSS signal reception seriously,” he said. ■



*ION GNSS+ 2014 Program Committee: Dr. Frank van Diggelen, Marco Falcone, Dr. Allison Kealy, Doug Taggart (general chair), Dr. Terry Moore (program chair), Dr. Paul Groves, Bernhard Richer and Dr. John Raquet. Not pictured: Dr. Susan Skone.*

## Commercial, App Tracks Added

This year’s ION GNSS+ conference for the first time feature tracks dedicated to the commercial uses of location technology and applications based on GNSS capabilities.

The two tracks will cover a wide range of subjects including new consumer products, microelectromechanical systems (MEMS), high-accuracy uses and simulation and testing.

The commercial track also will feature product demonstrations on Wednesday including one technique that uses MEMS, GNSS, WiFi and signals of opportunity to determine a position.

The new tracks, whose presentations do not require the preparation of full technical articles, highlight and distinguish commercial and applications-oriented content from the more traditional peer-reviewed papers. Among the subjects covered in applications sessions are detecting and classifying sea ice and the development of an e-navigation test bed in Europe.

Aviation-focused talks include ones on advanced RAIM and combining GPS and GLONASS for aviation and navigation technologies to help integrate unmanned aircraft into the regular airspace. As might be expected some of the land application

presentations involve techniques supporting vehicle-to-vehicle systems.

These include using images to derive bearing and a new robotic testing facility that utilizes Locata technology for testing crash-avoidance applications.

The consumer track is no less wide-ranging. There will be presentations on subjects including multi-GNSS products and EDAS, a service utilizing EGNOS data to improve services.

Although some commercial products such as the Apple iPhone can already incorporate signals from GPS and GLONASS, the prospect of having numerous signals from three, four or even five constellations has researchers looking at optimizing search strategies and developing new algorithms. Papers on these and a variety of new receivers and techniques designed to take advantage of multiple sets of navigation satellites will be presented Friday morning.

Other presenters plan to take a more terrestrial approach. They will explore pedestrian dead reckoning and a smart phone technique for estimating step length based on motion recognition and adaptive gait cognition. ■



## New Products & Company News @ ION GNSS+

### Boeing to Demonstrate GPS-Enabled Mobile FlightDeck

Boeing (**Island Booth B**) solutions and innovations in positioning, navigation, and timing (PNT) will feature the Boeing-built GPS IIF satellites now being launched that are setting new records for accuracy. Other satellite displays include the L-band digital payload technology and Combat Survivor Evader Locator (CSEL) radio that incorporates GPS and is the U.S. Department of Defense Program of Record for Joint Search and Rescue.

Also participating will be Jeppesen, a Boeing subsidiary, with demonstrations of its electronic flight bag, the GPS-enabled Mobile FliteDeck, for commercial and military applications. Attendees will be able to see first-hand the enhanced situational awareness that GPS delivers in the taxi position as well as during the enroute phase of flight.

### Rohde & Schwarz Simulator Demo at ION GNSS 2014+

Rohde & Schwarz (**Island Booth I**) will be demonstrating its SMBV100A simulator and is offering a new Wireless Standards

poster for visitors to its booth. Based on a digital vector signal generator, the SMBV100A supports realtime and hybrid configurations up to 24 dynamic GPS, GLONASS, Galileo, BeiDou, and QZSS satellites and can be synchronized for multi-channel RF solutions.

Rohde & Schwarz will be demonstrating its latest SMBV100A solutions and technologies along with dedicated solutions to support navigation and GNSS testing including:

- high signal dynamics, simulation of spinning vehicles and precision code (P code) simulations
- field-to-lab capture and playback solutions
- interference hunting and direction-finding solutions.

### UnicoreComm Offers

Unicore Communications, Inc. (**Booth 118**) offers its UM220-INS, a BeiDou/GPS+MEMS inertial navigation module for in-dash automotive navigation and high-end navigation. Besides dual system (BeiDou+GPS) GNSS navigation, UM220-INS features a built-in 6-axis MEMS and can output GNSS+MEMS inertial positioning result, most suitable for applications requiring high accuracy, high reliability, and high continuity positioning.

### Take a Chance on Physics at GPS World Exhibit

Scientists and engineers of the GNSS persuasion can test their knowledge of the two-body model and Keplerian orbits in a practical application at the roulette wheel in GPS World's booth (#224-#226). Those successful in their predictions of the fall of the ball will mathematically increase their chances of winning a Go-Pro Hero video camera, a pair of tickets to the magazine's Leadership Dinner, or a bevy of \$50 gift cards.

Simply fill out a subscription to GPS World and receive five chips for play at the roulette table. This is the magazine's way of celebrating its 25th anniversary. A drawing will be held during the afternoon break on Thursday, at approximately 3:40 p.m.

### Topcon Launches Two UAS Mapping Systems

Topcon Positioning Group (**Booth 419/421**) has released two unmanned aerial systems (UAS) for mapping — the Sirius Pro and Sirius Basic. Both systems are designed to produce accurate solutions for the automated mapping of a wide range of sites — regardless of terrain — including construction sites, mines and quarries, and for use in land surveying, power line and pipeline inspection as well as precision agriculture field mapping.

The fixed-wing systems resulted from a partnership with MAVinci GmbH, a UAS development company with which Topcon recently entered into a worldwide distribution agreement.

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*Systems Panel Update continued from page 1*



*Taking part in the GNS systems update panel discussion, from left to right: Dr. Xiancheng "Hunter" Ding, BeiDou; Mr. Qiao Hua Huang, BeiDou; Col. Matthew Smitham, GPS; Mr. Yoshiyuki Murai, QZSS; Mr. Marco Falcone, Galileo; Mr. Eric Chatre, Galileo*

and an incorrect plane more than 3,000 kilometers off target.

Falcone said his team has been working intensely to determine if the satellites, which are otherwise healthy, can be at least partially recovered. Among the considerations are the flight dynamics of moving the two spacecraft and the impact of the radiation they are experiencing in their current location. The radiation can shorten the satellite's lifetime, said Falcone. "It's very dangerous for the satellite."

The other three satellite navigation programs represented on the panel are also planning their next steps. (Though a fixture at previous program updates, no member of Russia's GLONASS team appeared to brief the audience.)

### BeiDou

Qiao Hua Huang, deputy director of the China Satellite Navigation Office, said China will launch four to five new-generation BeiDou satellites in 2015. These satellites will offer better performance, including rubidium clocks, new signals, and an improved ability to integrate with other GNSS systems.

One of the new signals will be crafted to be compatible with GPS while another signal will be compatible with Galileo. The program also plans to launch an augmentation system at about the same time.

Huang added that by the end of this year he expects China will publish a white paper

detailing BeiDou development concepts and perspectives.

### QZSS

Japan is also readying satellites for launch in its Quasi-Zenith Satellite System (QZSS). The QZSS program plans to loft three spacecraft by the end of 2017, with full operational capability for the four-satellite constellation by 2018. Of those, three spacecraft will be in a quasi-zenith orbit and one in a geostationary orbit.

Japan is considering expanding the constellation to seven satellites, said Yoshiyuki Murai, executive director for QZSS utilizations at Quasi-Zenith Satellite System Services, Inc. The program is also planning an augmentation service able to reach a 10-centimeter level of accuracy.

### GPS

The United States has plans for one more launch this year and three more satellites in storage, said Col. Matthew Smitham, deputy director of the GPS Directorate. The program is also poised to set another IIF satellite healthy — giving the program 39 satellites on orbit of which 32 would be transmitting operational signals at any given time.

The work on the new ground system is going a bit less smoothly. The program has been delayed and will not deliver Block 1 until 2018 with Block 2 to follow shortly after in 2019. ■

**Passing the Torches****ION Satellite Division Elects New Officers**

This past summer the Satellite Division held its election for Satellite Division Officers who will take office at the conclusion of ION GNSS+ 2014.

The following individuals were elected and will serve on the Satellite Division Executive Committee for two-year terms: Chair, Dr. John Betz, The MITRE Corporation; Vice Chair, Dr. Frank van Diggelen, Broadcom; Secretary, Mr. Doug Taggart, Overlook Systems Technologies; Treasurer, Dr. Grace Gao, University of Illinois.

Dr. Jade Morton will continue to serve on the Satellite Division



*ION Satellite Division Officers: Dr. John Betz (vice chair), Dr. Xiancheng (Hunter) Ding (BeiDou advisor), Dr. Anthea Coster (secretary), Patricia Doherty (ION president), Dr. Jade Morton (chair), Dr. Eric Châtre (Galileo advisor) and Dr. John Raquet (immediate past chair). Not pictured: Dr. Mark Petovello (treasurer), Hiroyuki Noda (QZSS advisor), Dr. José Ángel Ávila Rodríguez (European advisor) and Yuanxi Yang (Asian advisor).*



*ION GNSS+ 2014 Panel Discussion Chairs: Glen Gibbons, Dr. Frank van Diggelen, Dr. John Betz, Dr. Todd Humphrey, Alan Cameron (moderator), Didier Faivre, Dr. Frank van Grass, Dr. Dorota Grejner-Brzezinska and Dr. Didier Flament.*

Executive Committee for an additional two years as the Immediate Past Chair. Two International Technical Representatives will also be appointed.

Dr. Jade Morton, out-going Satellite Division Chair, will be honored during Friday's awards luncheon where she was recognized for her visionary leadership of the Satellite Division. During her term she has been an avid supporter of the Satellite Division's outreach efforts, supporting developing technical events such as: the ION's Robotic Lawn Mower and Autonomous Snowplow Competitions; ION GNSS+ Student Awards; and initiatives for the sustainable development of navigation, science and technology in developing nations. She has participated in the further development of the ION GNSS+ conference's organization as both the program and general chair of this meeting in 2012 and 2013; as an ION GNSS+ tutorial instructor; and as a past chair of the Division's Parkinson Awards Committee. Additionally, Dr. Morton has been instrumental in facilitating the international exchange of technical information between GPS and Beidou programs during this meeting, and in the organization and leadership of expert GPS panels that have presented at the Chinese Satellite Navigation Conference over the past number of years.

The Satellite Division would like to thank Dr. Anthea Coster and Dr. Mark Petovello who have served as Satellite Division secretary and treasurer, respectively, for the past two years, Dr. John Raquet, who has served on the Satellite Division Executive Committee for the past six years, and Yuanxi Yang and Dr. José Ángel Ávila Rodríguez, who have served as international technical advisors. The Institute also extends its thanks to all the other volunteers who have provided counsel and guidance over the past two years. ■



*ION GNSS 2014+ Status of the Systems Panel: Dr. Xianchang (Hunter) Ding (BeiDou), Quai Hua Huang (BeiDou), Dr. John Betz (chair), Marco Falcone (Galileo), Dr. Eric Châtre (Galileo) and Col Matthew Smitham (GPS).*

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**More Product & Company News****NovAtel Expands Pinwheel Antenna Product Line**

NovAtel Inc. (**Island Booth J**) has introduced the GPS-702-GG-HV to its line of high-performance Pinwheel antennas. Tracking L1/L2 GPS and L1/L2 GLONASS frequencies, customers can use the same antenna for GPS-only or dual-constellation applications, reducing equipment costs and need for future redesign. Enclosed in a durable, waterproof housing, the phase center of this antenna remains constant as the azimuth and elevation angle of the satellites change.

**Trimble Announces Wireless Data Link for GNSS RTK**

Trimble (**Island Booth H**) has launched the new Pacific Crest XDL Rover 2, an advanced, high-speed, wireless data link built to withstand the rigors of GNSS/RTK surveying and precise positioning. UHF data can be transmitted via Bluetooth to a paired host device for operational efficiency. Available now, the XDL Rover 2 is a lightweight, ruggedized UHF receiver de-

signed for digital radio communications between 403 and 473 MHz in either 12.5- or 25-kHz channels.



*Lockheed Martin held a congratulatory ceremony for the United States Air Force in celebration of Lockheed Martin-built GPS IIR/IIR-M reaching 200 collective years of on-orbit operations. Pictured below (left to right): Don Edsall, GPS IIR/IIR-M program manager, Col Matthew Smitham, deputy director USAF GPS directorate; Dr. Jade Morton, ION Satellite chair; Lt. Col Jacob Freeman, deputy chief engineer, GPS Directorate; and Mark Stewart, vice president Navigation Systems for Lockheed Martin.*



## Panels Look at Emerging Tech, Standards, Threats

The focus is on the future in nine expert panels being held this year with updates on the plans being pursued by different GNSS programs and discussions about potential technologies and emerging threats to satellite navigation services.

Thursday morning begins with a debate on what high precision technology might look like in 2020 as envisioned by experts from Topcon, Trimble, Leica Geosystems, Altus Positioning Systems and China's WuHan Navigation.

The second morning panel will tackle GNSS authentication with an emphasis on designing signals able to resist spoofing as opposed to relying on the receiver to thwart misdirection.

The Thursday afternoon panels will follow a similar course. Starting at 1:45, experts from the Air Force Institute of Technology, Broadcom, RMIT and Auburn Universities and the United Kingdom's Lighthouse Authorities will opine on the future of navigation including what the dominant technologies might be and the type of performance that users can expect as well the type of applications that might emerge.

The second panel will look at threats to GNSS systems. Moderated by Professor Todd Humphreys, whose students have proven it's possible to spoof the GPS signals used by a drone and an ocean cruiser, the panel will look at GNSS vulnerabilities and threats. Experts from Stanford and Cornell Universities, MITRE, LS Consulting and the German Aerospace Center will talk about intentional and unintentional interference and how to improve receivers to help handle signal issues.

The conference wraps up Friday with two panels that examine the confidence users should have in today's navigation systems. In the morning session, GNSS — Our Strongest Asset or Weakest Link?, speakers give their perspectives on the weaknesses in today's GNSS systems, the non-technical aspects of those weaknesses and what the consequences might be if they are not addressed.

In the afternoon officials will give updates on the high-integrity systems being implemented around the world as well as presentations on WAAS, EGNOS and MSAS, the systems developed for the U.S., Europe and Japan respectively,

and talks about systems in China, Korea, India, Russia and Africa. The results of research into dual-frequency and bi-constellation systems will also be presented.

To help attendees choose among the conference's many panels ION hosted its first ever "lightning round" panel Tuesday night in conjunction with the plenary session. Moderators from all the panels had five minutes each to pitch the hot topics being discussed in their forums and entice conference goers to join their discussions. ■

## Septentrio, Altus Combine U.S. Sales

Altus Positioning Systems, a subsidiary of Septentrio Satellite Navigation NV, has assumed responsibility for Septentrio products in North and South America.

Septentrio (**Booth 318/320**), a long-established manufacturer of high-end GNSS receivers, is consolidating its sales, service, and customer support functions for the Americas in Altus' facility located in Torrance, California. ■

## ION GNSS+ 2014 Student Award Winners

The Institute of Navigation (ION) Satellite Division is proud to announce the winners of the ION GNSS+ 2014 Student Paper Awards.

Each year, the ION Satellite Division presents Student Paper Awards to encourage student participation in GNSS+ and to support continued involvement in GNSS after graduation.

Student papers are selected based on technical content, innovation, importance and timeliness of the subject matter; and conciseness, clarity and completeness of the written material and are evaluated by recognized industry and academic experts. Awards are presented to the lead authors

of the best papers.

To qualify, students must have been full-time undergraduate or graduate students in engineering, science, mathematics or other related fields at the time their papers were written. Papers cannot be co-authored by a working professional or a faculty member.

Student award winners receive a full complimentary conference registration and a travel stipend and will be recognized during the Friday Award Luncheon.

Congratulations to the following students who received 2014 student awards:

**Srinivas Bhaskar**, University of Calgary, Canada, *Exploiting Quasi-periodicity*

*in Receiver Dynamics to Enhance GNSS Carrier Phase Tracking*; **Chien-Hsun Chu**, National Cheng Kung University, Taiwan, *The DG Performance Verifications of UAV Borne MMS Payload with two Tactical Grade Low Cost MEMS IMUs Using New Calibration Method*; **Amir Khodabandeh**, Curtin University of Technology, Australia, *Single-differenced Satellite Phase bias Determination Using an Array of GNSS Antennas*; **Lei Wang**, University of College London, United Kingdom, *Kinematic GNSS Shadow Matching Using a Particle Filter*; **Yingwei Zhao**, University of Darmstadt, Germany, *A New Method in Modelling the IMU Stochastic Errors*. ■

