The next step into active traffic safety and autonomous driving

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Thomas Seiler, CEO
Costas Meimetis, Senior Principal Corporate Strategy
Pedro Lopez Estepa, Senior Product Marketing Manager
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What do we stand for

Have you ever driven a car with a built-in navigation, flown a drone, or worn a smart watch?

If so, you've already experienced our technology. At u-blox, we design and develop essential technologies that deliver precise position information and wireless connectivity to for smart devices connected to the Internet.

We are a public company, strongly growing and financially very stable and profitable.
Strong position in automotive markets

Global footprint

Revenues by geographic region

Revenue split per market for 2017
Automotive market
High quality and robustness

Typical applications
→ Vehicle telematics
→ Emergency call systems
→ Insurance boxes
→ Autonomous vehicles

u-blox advantages
→ Automotive quality
→ Dead reckoning solutions
→ Seamless integration of positioning and wireless
→ Robust performance
→ Long product lifetime
Automotive challenges as of today...

Traffic safety
- Demands to make transportation safer are more pressing than ever
- > 1.2m people die each year on the roads worldwide

Increasing pollution
- Looking for ways to make transportation more sustainable
- 14% of all global warming emissions comes from transportation

Increasing traffic intensity
- With more vehicles on the roads, the need for traffic management increases
- About 12 billion liters of fuel wasted due to traffic congestions in US
Today we are unveiling the next step towards increased traffic safety and autonomous driving

UBX-P3 is industry’s smallest concurrent dual-channel V2X communication chip

UBX-P3 chip with a combination of unique features:
→ Concurrent dual-channel
→ Flexibility of installation
→ Smallest size
→ Low power
V2X applications
V2X communication technology the next step

Mature technology ready for immediate deployment

→ Achieved only if vehicles have means to share information and create a common perception of their surrounding environments

→ Vehicle-to-everything (V2X) is a key enabling technology allowing vehicles to use dedicated short range communication to achieve such a vision

V2X DSRC/802.11p is mature and available for immediate deployment of V2X systems

Sharing data about speed, position, direction, intent, and more
V2X communication technology in practice
Key for improved vehicle safety

→ Unlike any other sensor in the vehicle:
  → Extends active traffic safety beyond Line Of Sight (NLOS) – “looking around the corner”
  → 360 degree awareness
  → Up to 1 km range
→ Possibility for vehicle-to-vehicle and vehicle-to-infrastructure connectivity
  → Enabling vehicles to have a collective perception even without an infrastructure in place
  → Infrastructure can enable even further enhancements
V2X enables wide-ranging applications
Making transportation safer, more efficient, and more sustainable

→ Active traffic safety
→ Smart cities and traffic management
→ Platooning
→ Autonomous driving
→ Other applications
Active traffic safety

→ By communication with each other, vehicles will share a common perception and awareness of other traffic participants.
→ Information may indicate blind spot warnings, when vehicles brakes in front of you or intersection movement.

Results in:

→ Increased road safety in general
→ Reduced traffic accidents
→ Reduced injuries and fatalities
Applications
Making transportation safer, more efficient, and more sustainable

Smart cities and traffic management
→ Using information shared with Road Side Units (RSU), traffic managers will be able to actively manage the system in real time
→ Information may be about a nearby accident, traffic jam, roadwork or traffic light management

Results in:
→ Smooth traffic flow
→ Reduced CO₂ emissions
→ Cost savings
Applications
Making transportation safer, more efficient, and more sustainable

Platooning

→ Platooning uses wireless connectivity to let trucks drive in a very compact formation
→ Truck platoons connected using direct Vehicle-to-Vehicle (V2V) technology experience reduced air drag

Results in:

→ Reduced fuel consumption
→ Reduced CO₂ emissions
→ Reduced needs for drivers (once autonomous driving comes true)
Autonomous driving - vision

- The vision of highly autonomous driving is achieved only through a combination of many building blocks
- Aggregated sensor data is key
  - High Precision GNSS
  - V2X communication
- are most essential sensors
Applications
Making transportation safer, more efficient, and more sustainable

Autonomous driving

→ V2X is an enabling technology that one day will make self-driving cars much safer by helping them see and react to invisible danger

→ Active safety and autonomous driving are strategic focus areas for u-blox

→ High Precision GNSS (HGP) and V2X are key ingredients and the foundation of our automotive portfolio in this market space
Sharing location, velocity, and trajectory between cars:
→ Increases safety
→ Enhances convenience

V2X adds a new dimension to High Precision GNSS
→ Creates a common collective perception
→ Adds an extra layer of redundancy & robustness when other sensors fail
Applications
Making transportation safer, more efficient, and more sustainable

Autonomous driving – heading towards level 5

- **Driver Only**
  Driver undertakes lane holding and lane changing activities.

- **Assisted Driving**
  Driver carries out all lane holding or lane changes.

- **Partly Automated**
  System handles lane holding and lane changes in a special application case.

- **Highly Automated**
  Driver no longer needs to continuously monitor the system. Must potentially be available to take over.

- **Fully Automated**
  No driver is necessary in special applications.

- **Driverless**

- **LEVEL 0**
  - **LEVEL 1**
  - **LEVEL 2**
  - **LEVEL 3**
  - **LEVEL 4**
  - **LEVEL 5**

**u-blox solutions**
with functional safety & integrity

- **u-blox High Precision GNSS**
- **and V2X**
Applications
Making transportation safer, more efficient, and more sustainable

Autonomous driving – potential market

Source: u-blox compilation, Research Automotive Horizontal Team, Q1/2018
Applications
Making transportation safer, more efficient, and more sustainable

Additional applications for deployment today
→ Mining
→ Agriculture
→ Trains
→ Unmanned vehicles / drones
V2X market
Activities ongoing in all regions

→ DSRC/802.11p field trials increasing world-wide, many moving to operational phase
→ Legislation activities are ongoing in all regions
→ Most Tier-1 suppliers and OEMs have plans for DSRC/802.11p solutions
→ Harmonized efforts to speed up the rollout of DSRC/802.11p in the 5.9 GHz spectrum

Trials have been conducted, technology is widespread and now ready for mass market deployment
Traffic safety drives V2X market

V2X market potential

US/EU/APAC forecast:

→ DSRC/802.11p penetration in new light vehicles is projected to reach an accumulated volume of 157 M units by 2026 (US/EU/APAC)

→ Adding smaller regions and aftermarket volumes reaching 206 M units in total

→ Revenue of hardware segment

→ grow from the initial markets in 2018 to yearly revenue of USD 5.1 billion on globally

→ CAGR of above 60%

Source: ABI Research, Intelligent Transportation Systems Market Data, QTR 4 2017
Toyota and Lexus became the world’s first to commercialize vehicles equipped with DSRC

- More than 100,000 vehicles equipped with DSRC on the road
- Start deployment of DSRC/802.11p systems on their vehicles in the US from 2021
- GM-Cadillac equipped with DSRC on streets in US/Canada since 2017
- Volkswagen Group:
  - Statement on February 18, 2018:
    - “Group-wide roll-out of WLANp standard in volume models from 2019 […]”
    - “Standard equipment on new models without additional cost […]”
V2X enabling cooperative driving

Collision avoidance
V2X enabling cooperative driving

Example: Intersection Management Assist (IMA)

→ Higher traffic throughput
→ Lower fuel consumption
→ Higher driver convenience
u-blox in V2X: Connecting the dots

2014
Antcor Acquisition [802.11x IP]

2015
Car2Car Consortium

2015
Lesswire Asset Acquisition [V2X Modules]

2015
Cohda MK5 design acquisition and market introduction of THEO module

2017
VERA-P1 module market introduction

2018
Launch of UBX-P3 V2X platform
UBX-P3 – we are not starting from scratch
Committed supplier of technologies of traffic safety and ADAS solutions

→ Leading supplier of automotive position technology – an important part in V2X systems

→ Experienced automotive supplier of connectivity technologies and products

→ u-blox already offers two generations of V2X modules
→ Involved in key V2X trials
→ Technology supplier to existing V2X chip industry

Next step – our own V2X DSRC/802.11p chip - UBX-P3
### Unique combination of technology and product offerings

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#### Integrated Circuits

- Strong synergies between the technologies
- Complete solutions
- Full owner of technology
- Maximum competence
- Solid product roadmaps
- Services on top of HW
- Improved functionality
- Lifetime support

#### Modules

- CellLocate® (modem based positioning)
- AssistNow™ (world wide GNSS assistance service)
- GNSS Correction Data (for high precision)*
- FOTA (Firmware over the air)
- Lifetime Security

*through Sapcorda, a Joint Venture with industry partners
UPX-P3
UBX-P3
The industry’s smallest concurrent dual-channel V2X chip

- Prepared for global footprint – US, Europe, and Japan
- Built on the success of the THEO-P1 and VERA-P1 V2X modules and our experience as technology supplier to existing V2X chip industry
- Developed entirely in-house based on proprietary IP
- Takes u-blox’s commitment to shaping the future of active safety and autonomous driving technologies to the next level
UBX-P3 product – a combination of unique features

- **Operation modes**
- **Smallest size**
- **Flexibility for installation**
- **Low power consumption**
UBX-P3
The industry’s smallest concurrent dual-channel V2X chip

Concurrent dual-channel / diversity - robustness and coverage around the vehicle

→ Supports dual channel operation
  → Concurrent communication on two channels
  → Safety and service messages can be processed continuously providing greater safety in traffic

→ Or single channel operation with diversity
  → Enables the chip to simultaneously communicate on the same channel using two antennas, thus:
    → Providing vehicles full coverage around car
    → Useful for roadside units along the road

On the road, this means increased reliability, robustness, and safety
UBX-P3 product – a combination of unique features

- Operation modes
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UBX-P3
The industry’s smallest concurrent dual-channel V2X chip

**Flexibility for installation**

→ Automotive grade: AEC-Q100 grade 2 (-40°C to +105°C), supporting deployment in harsh environments
→ Roof-top installation possible
  → ETH interface for “distributed” system
→ Support Smart Antenna deployment

Supports flexible deployments in vehicles and road-side infrastructure
UBX-P3 product – a combination of unique features

- Operation modes
- Smallest size
- Flexibility for installation
- Low power consumption
ublox AG

UBX-P3
The industry’s smallest concurrent dual-channel V2X chip

Compact form factor
→ 802.11p DSRC chip in the smallest package: 9 x 11 mm
→ Integrated power management
→ Integrated security verification engine

The optimal form factor supports various design options in vehicles and road-side infrastructure
UBX-P3 product – a combination of unique features

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UBX-P3
The industry’s smallest concurrent dual-channel V2X chip

Low power design
→ Power consumption less than 1 W
→ Low power consumption implies low cost of operation
→ Minimal heat generation allows installations even in tight spaces

Thinking of sustainability – with a design consuming less power than industry standard
UBX-P3 schedule

- June 5, 2018: Announcement
- 2018: Prototypes, lead-customer
- Q4, 2019: Mass production
UBX-P3 in real life
Technology outlook

→ **Current solutions 802.11p**
  → Industry has invested huge efforts in technology and trials during past years. Now ready for mass market deployment.

→ **Standardization work underway for the next generation DSRC/802.11p**
  → 802.11p will evolve into 802.11px

→ **Other technologies in this field**
  → Cellular based V2X: C-V2X
    → C-V2X is seen as a future step of the cellular technology (LTE and 5G), but it will take many years until it can be deployed in a manner like 802.11p.
    → C-V2X is likely to complement and enhance the use cases of V2X
Conclusion
Summary / Conclusion

Key takeaways

→ u-blox commitment to active traffic safety and in the future autonomous driving
→ Technology is now ready for commercial deployment
→ Today good potential for new vehicles but also for aftermarket applications
→ u-blox providing two core technologies for these applications (HPG and V2X)
→ Will lead u-blox into strong market position towards autonomous driving
Numbers represents...

Number of injured persons on the roads in US and in the EU during duration of this presentation

271
30
Thank you for your attention