LAUREA
UNIVERSITY OF APPLIED SCIENCES

Prime Mover

Optimized Power Consumption of GNSS Devices Enables Improved Safety and Security Response in Remote and Sparsely Populated Areas

Dr. Jyri Rajamaki, Laurea

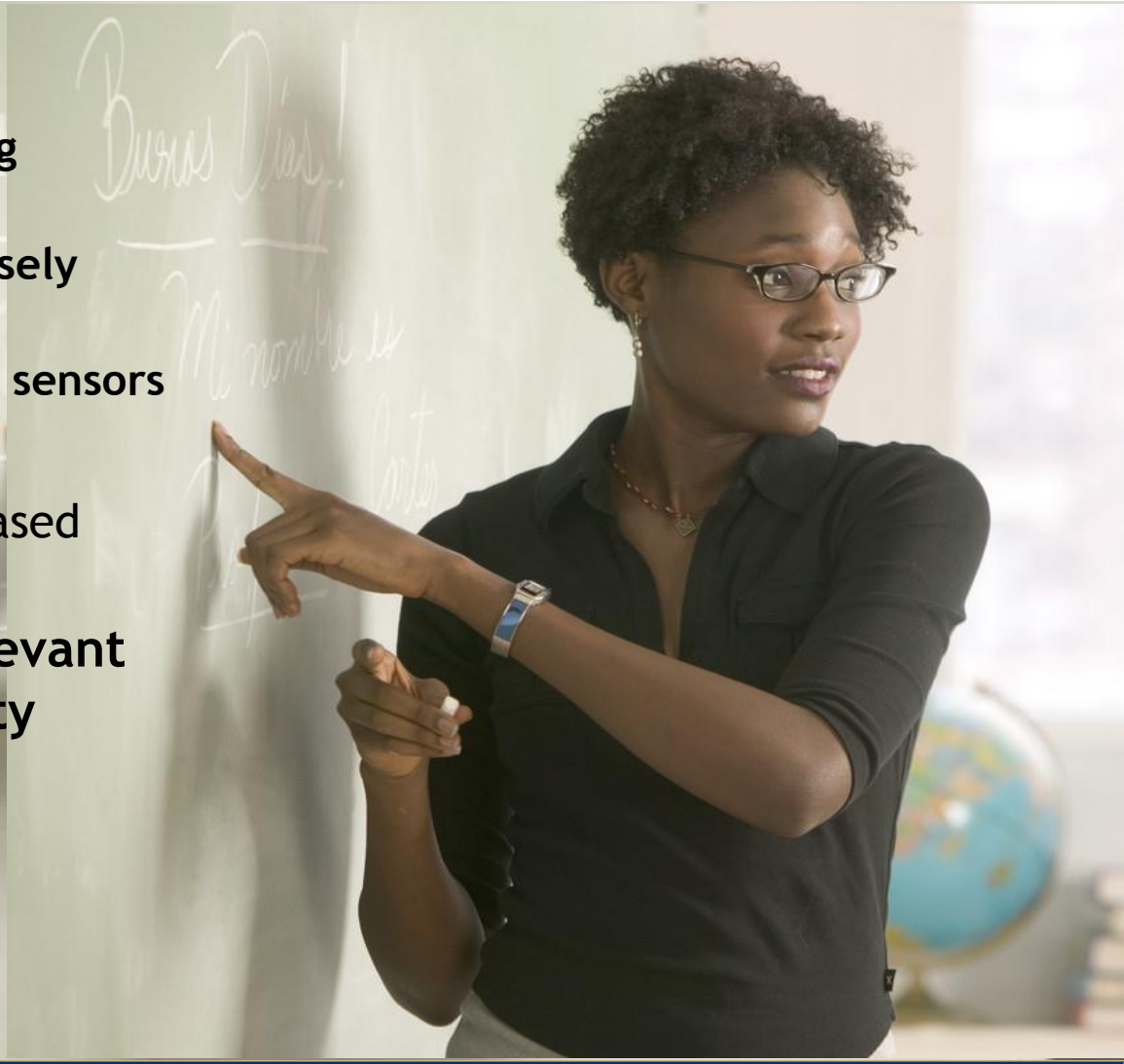
Lapland University Consortium
LUC TOURISM

Tourism Safety and Security System in Lapland

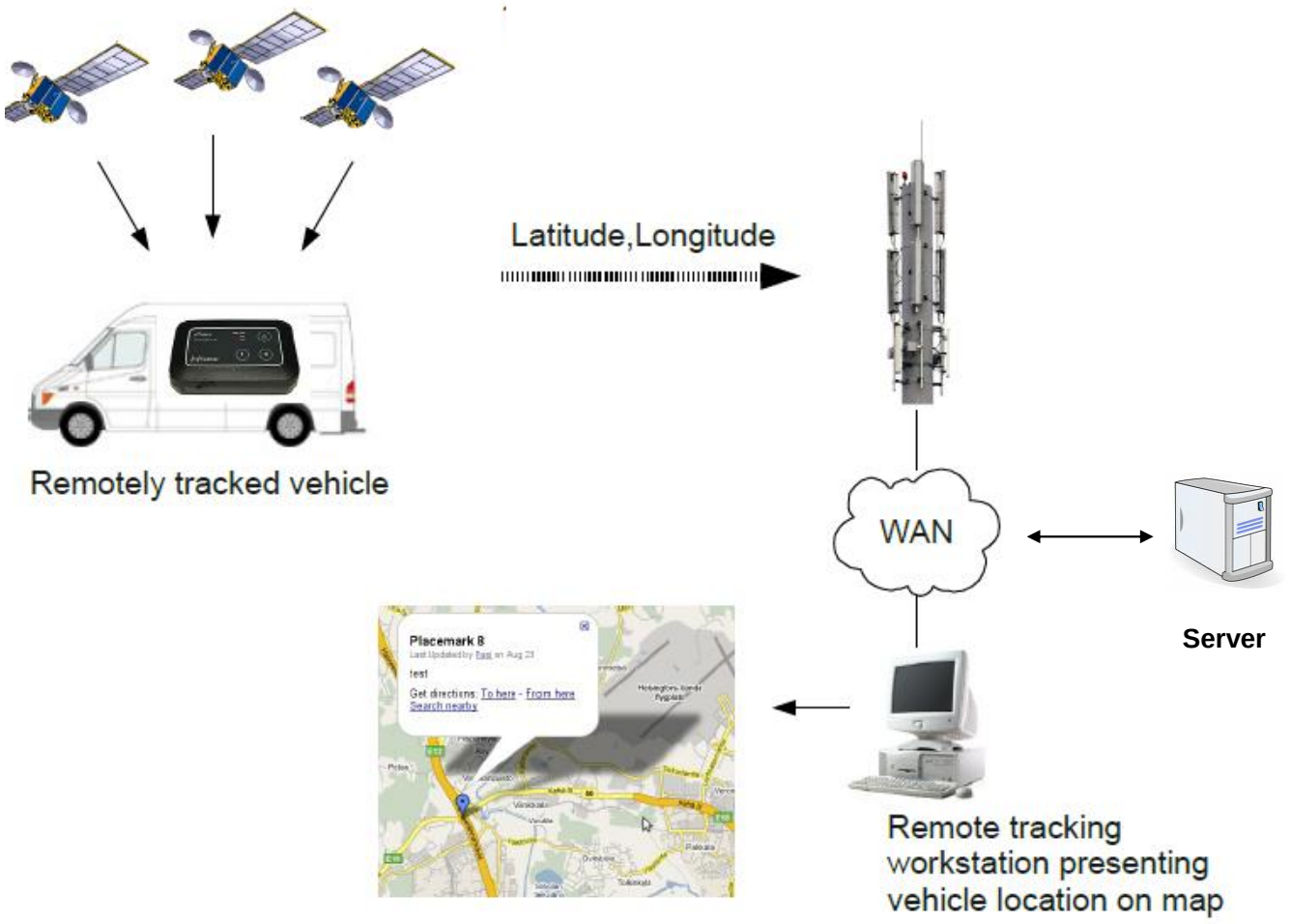
Lapland Institute for Tourism Research and Education

Contents

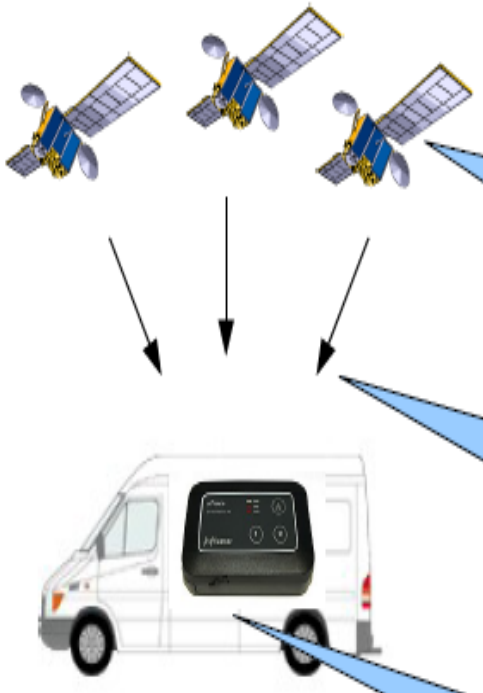
1. **Theoretical foundation**
   - **Concept of GNSS-based tracking systems**
   - **Challenges in Remote and Sparsely Populated Areas**
   - **Power consumption of tracking sensors**
2. **Empirical case**
   - **SATERISK project** - SATEllite-based tracking RISKs
3. **Conclusions and findings relevant to tourism and travel security**



Concept of GNSS-based tracking



Satellite and tracking segment elements



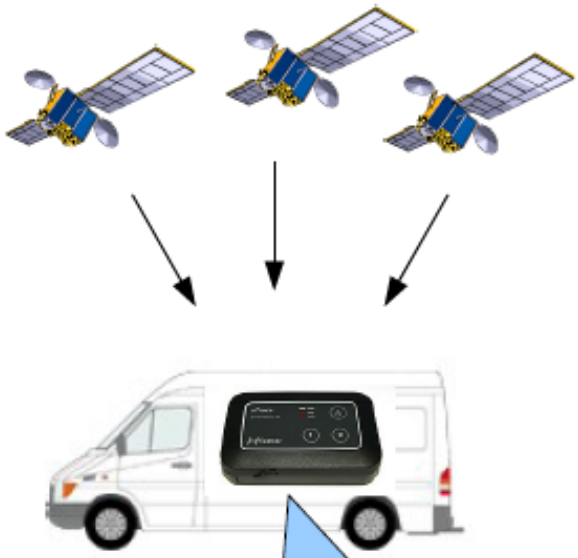
Remotely tracked vehicle

1. Space constellation
- GPS satellites
- At least 3 visible for successful positioning

2. Radio path
- Non blocked path for GPS signals
- GPS Signal strength is weak (below noise, ~150dBm)

3. Tracking device
- GPS receiver for navigation
- GSM terminal for communication

Mobile communication elements

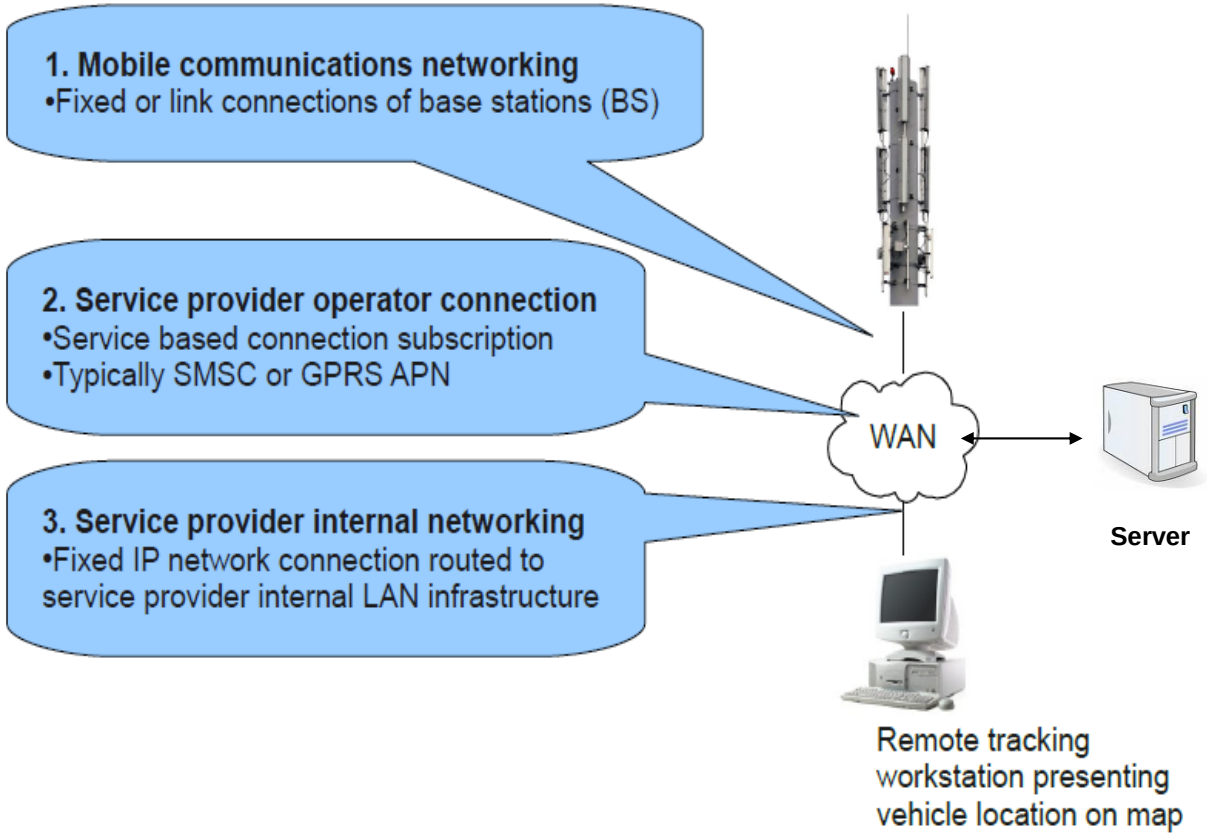


1. Mobile communication equipment
- Commercial provider, like GSM operator
- M2M communication party

2. Mobile communication Network
- Coverage
- Service availability
- Roaming

2. Mobile communication infrastructure
- Base stations
- Connections (fixed or links)

Fixed network elements



Data processing and end-user segment elements

Server

WAN

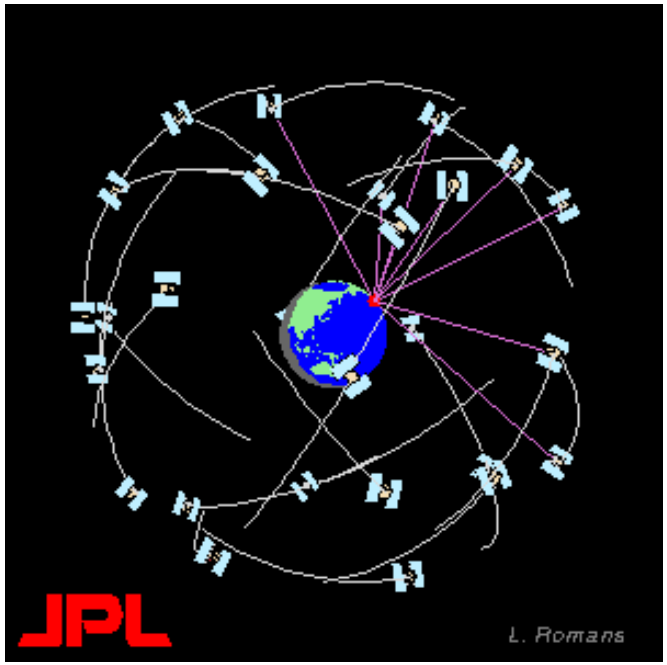
1. Tracking system internal communications
- Database communication for positioning inform.
- Database communication for mapping data
- External DB connections

Remote tracking workstation presenting vehicle location on map

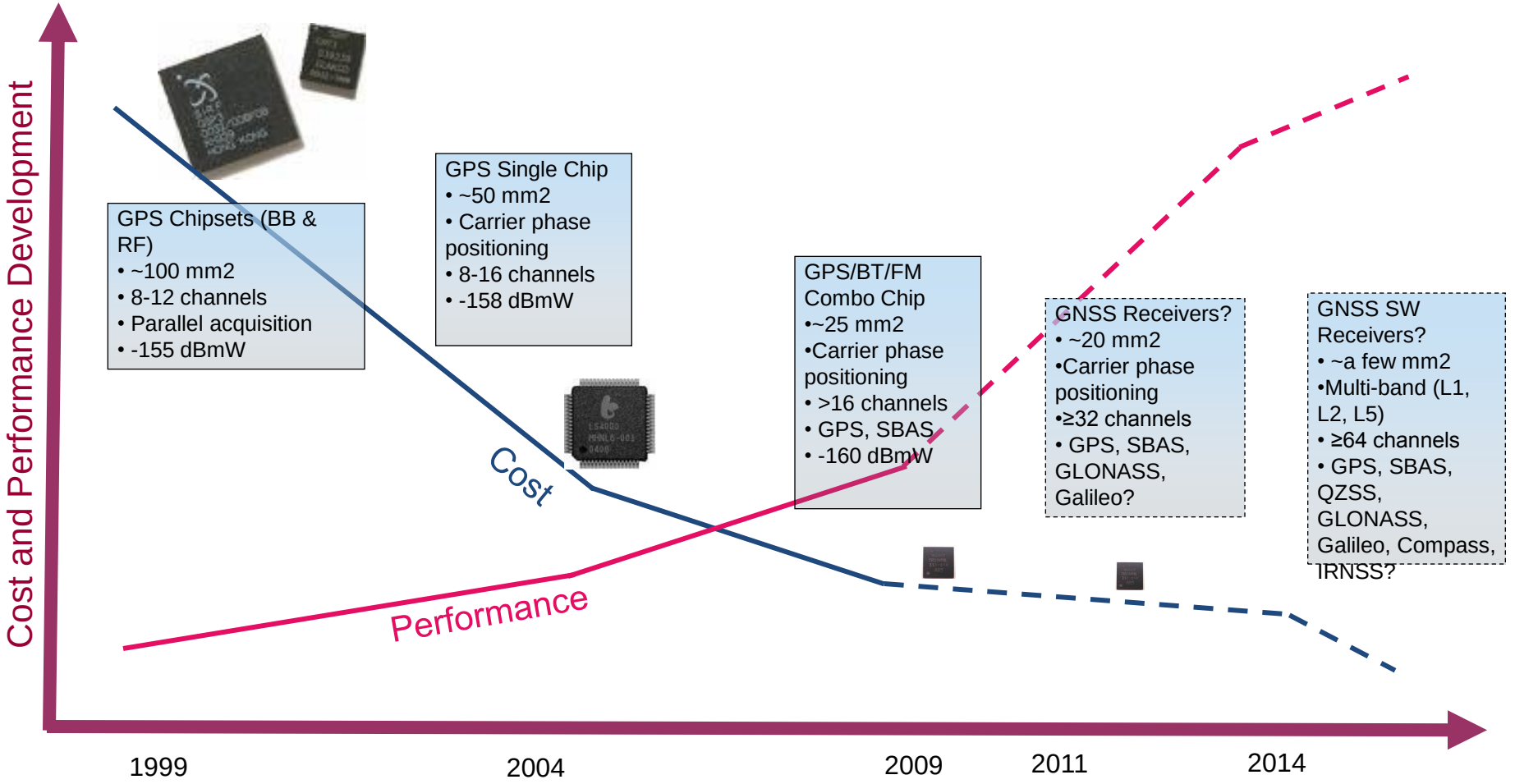
GNSS Systems – The most common and widely used positioning technique

- GPS (USA)
- GLONASS (Russia)
- Galileo (Europe)
- Compass (China)

- Quasi-Zenith (Japan) – Regional, not global system



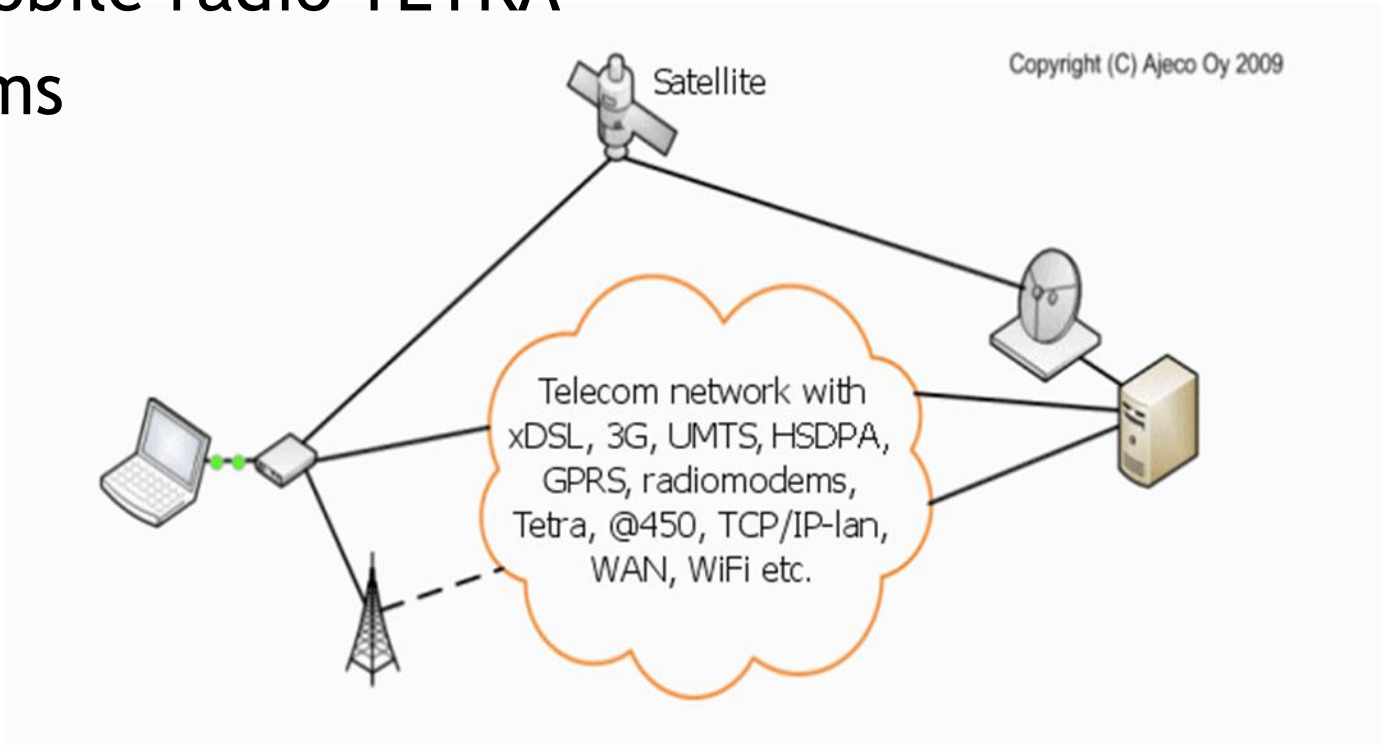
GNSS Receiver Technology Development



Source: Jari Syrjärinne, Nokia, 2009

Mobile communications

- Commercial cellular systems 2G/3G/4G
- Professional mobile radio TETRA
- Satellite systems



SATERISK – SATEllite-based tracking RISKs

Tracking is used to increase safety of logistics and optimize work flow, but does it always work that way? Do we know the risks? – ***Are we creating new risks?***

- Joint project with Laurea, University of Lapland, international universities, industrial partners and end-users
- 563.000€ (Tekes 60%) / 1.9.2008 – 31.12.2011

Pasi Kämppi's Master's thesis " Grounded View to Technical Risks of Satellite Based Tracking Systems: A Multi methodology Research" ***won best thesis of the year 2011 award*** *(20.000 thesis/20 awards)*

Tracking:
Remotely following the target with help of *Global Navigation Satellite Systems* (GNSS) systems and devices

Who is being tracked?
- private person
- employee
- criminal
- vehicle, ship
- property

Who is tracking?
- private person himself
- service provider
- employer
- authorities (police etc.)
- owner of the target

What are supporting systems?
- applications
- communication elements
- transferring position data
- encryption
- tracking devices

How?
- GPS
- Glonass
- Galileo

Where?
- National region
- EU/Schengen regions
- Outside EU (eg. Russia)
- Cross border tracking
- Crossing multiple countries

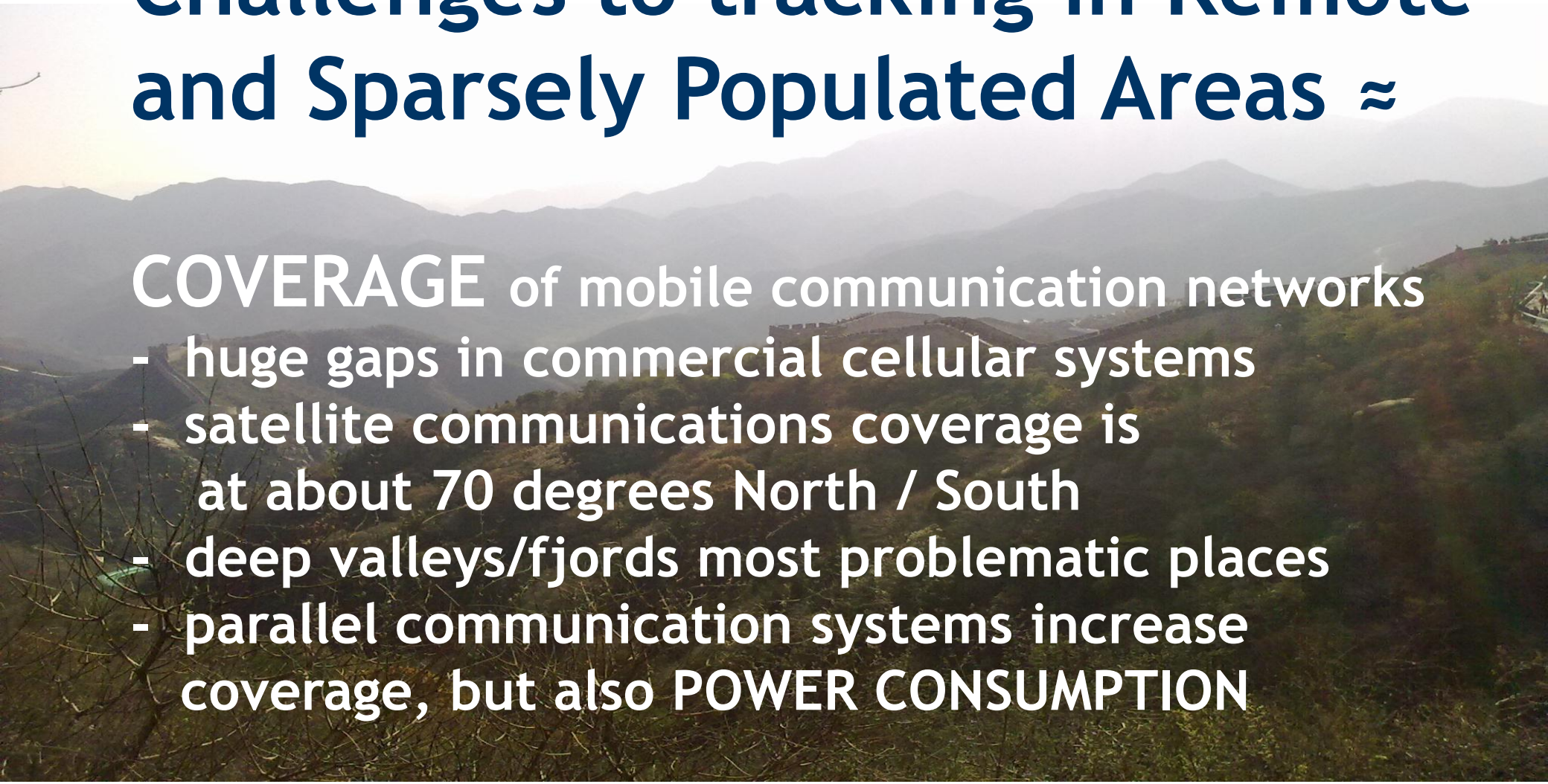
Why?
- navigation
- offering service
- commercial use
- increasing efficiency
- security
- rescuing
- protecting property

Source: www.saterisk.fi

Findings relevant to tourism and travel security

- Many companies are developing tracking sensors;
  - some even considering the power consumption.
- Majority consumes dreadful energy for long-lasting mobile use.
  - Current sensors are “not-smart”, requires command for almost all tasks.
- With artificial intelligence (AI), the tracking sensors are able to adjust according to a behavior of the target also making sensors more power efficient.
- There are solutions for technical surveillance and information gathering targeted strictly to professional law enforcement agencies (LEA) and their respective representatives.
  - A multi-talented, intelligent and smart tracking sensor can monitor the environment, e.g. light conditions, temperature, vibration, GNSS location and cell location. This information helps to visualize happening at location. Sensors’ own AI-brain makes necessary decisions, generates alerts and facilitates help in tough situation.

Challenges to tracking in Remote and Sparsely Populated Areas ≈

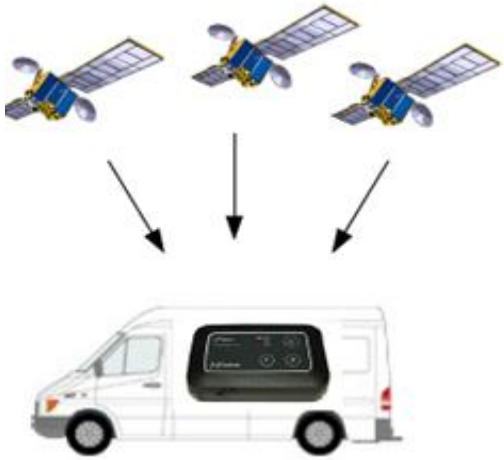


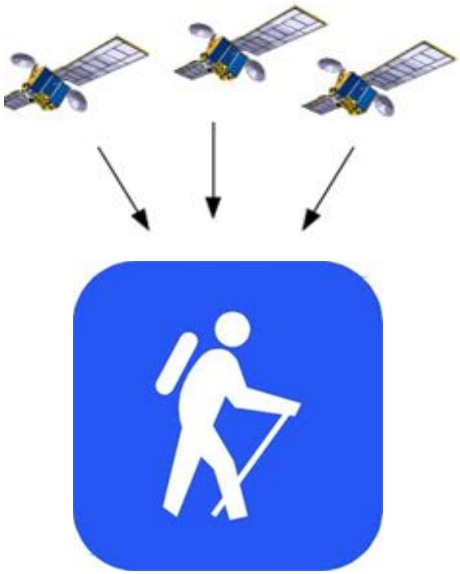
COVERAGE of mobile communication networks

- huge gaps in commercial cellular systems
- satellite communications coverage is at about 70 degrees North / South
- deep valleys/fjords most problematic places
- parallel communication systems increase coverage, but also POWER CONSUMPTION

Power consumption

- Not a real problem when tracking vehicles
- But a critical factory if only batteris are available





Big part of the power consumption: how to use equipment

With artificial intelligence (AI) tracking sensors are able to adjust according to the behavior of the target making sensors more power efficient.

Current development within LEA's technical surveillance and information gathering:

Optimizing power consumption

- identifying all the components (hardware, software modules, communication, GNSS capabilities) and their power consumption that will be installed in the tracking sensor.

Exploring for energy harvesting and other power sources

- Energy harvesting devices converting ambient energy into electrical energy (e.g., solar power, thermal energy, wind energy, salinity gradients, and kinetic energy), LEA sensors are often very small and require little power, but their applications are limited by the reliance on battery power. Scavenging energy from ambient vibrations, wind, heat or light could enable smart sensors to be functional indefinitely.
- On batteries new technology is based on the elements of lithium and sulfur. These two combine to yield a battery system with the highest theoretical gravimetric and volumetric energy densities of any known useful battery couple. This will enable many new LEA applications. The difference with Lithium-Ion is that the cell voltage is not anymore 3.6 V but varies nonlinearly in the range 2.5-1.7 V during discharge.

Why not utilize this development in other safety critical tracking systems? Smart belts?

Conclusions

- Excessive trust in GNSS-technology could end in disaster.
  - For example, GNSS-device battery may die in long-lasting hiking that leaves hikers with no way to navigate in the wilderness. Orienteering (map+compass) skills!
- GNSS-tracking systems enable many possibilities for improved safety and security response in remote and sparsely populated areas, especially if their energy consumption is optimized
  - Portable dynamo generating power?

Conclusions – Future work

- Utilizing the development of LEA's technical surveillance sensors in other safety critical tracking systems.
- The end-user should be the development target for the whole efficiency chain, from the sensor to the information.
  - It is essential as big part of the power consumption rely on how equipment behaves?
- Next step will be to look for energy harvesting; through other means which enables smart sensors for lasting performance.
  - Develop arctic co-operation with CIMES network/University of Alaska

Thank You

jyri.rajamaki@laurea.fi

www.saterisk.fi

www.laurea.fi