GIS

The Geographic Approach for the Nation

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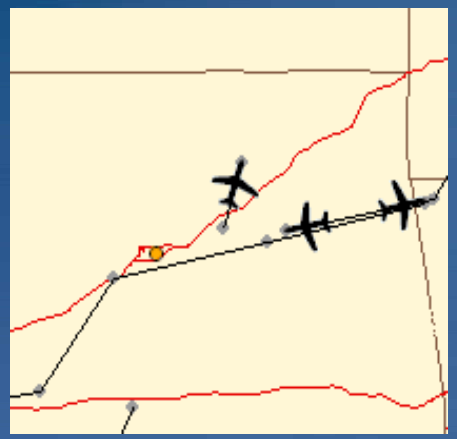
Tracking Solutions: Sensor Data Collections and First-Chance Analysis

David Kaiser

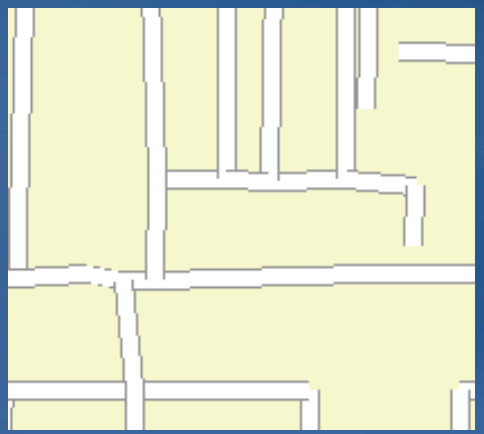
Types of Temporal GIS Data

Dynamic
something that moves



- Planes
- Vehicles
- Animals
- Satellites
- Storms

Discrete
something that "just happens"

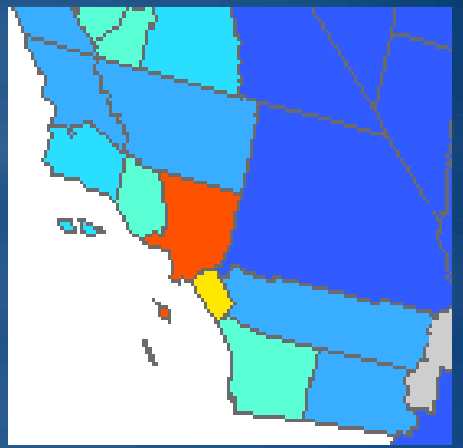


- Crimes
- Lightning
- Accidents

Stationary
stands still but records changes

- Weather Stations
- Traffic Sensors

Change
change or growth



- Population
- Distribution

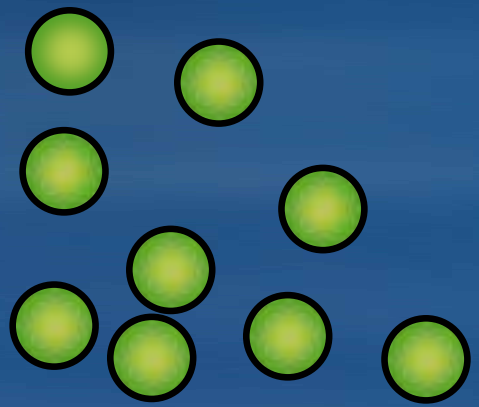
Time and Track Correlation

Time

Allows “Current” data to be shown

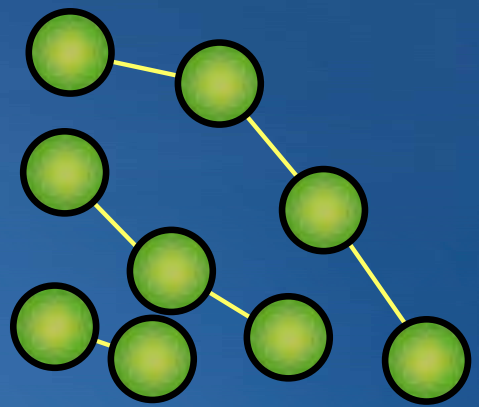
Correlation

Allows grouping by source



Traffic Accidents

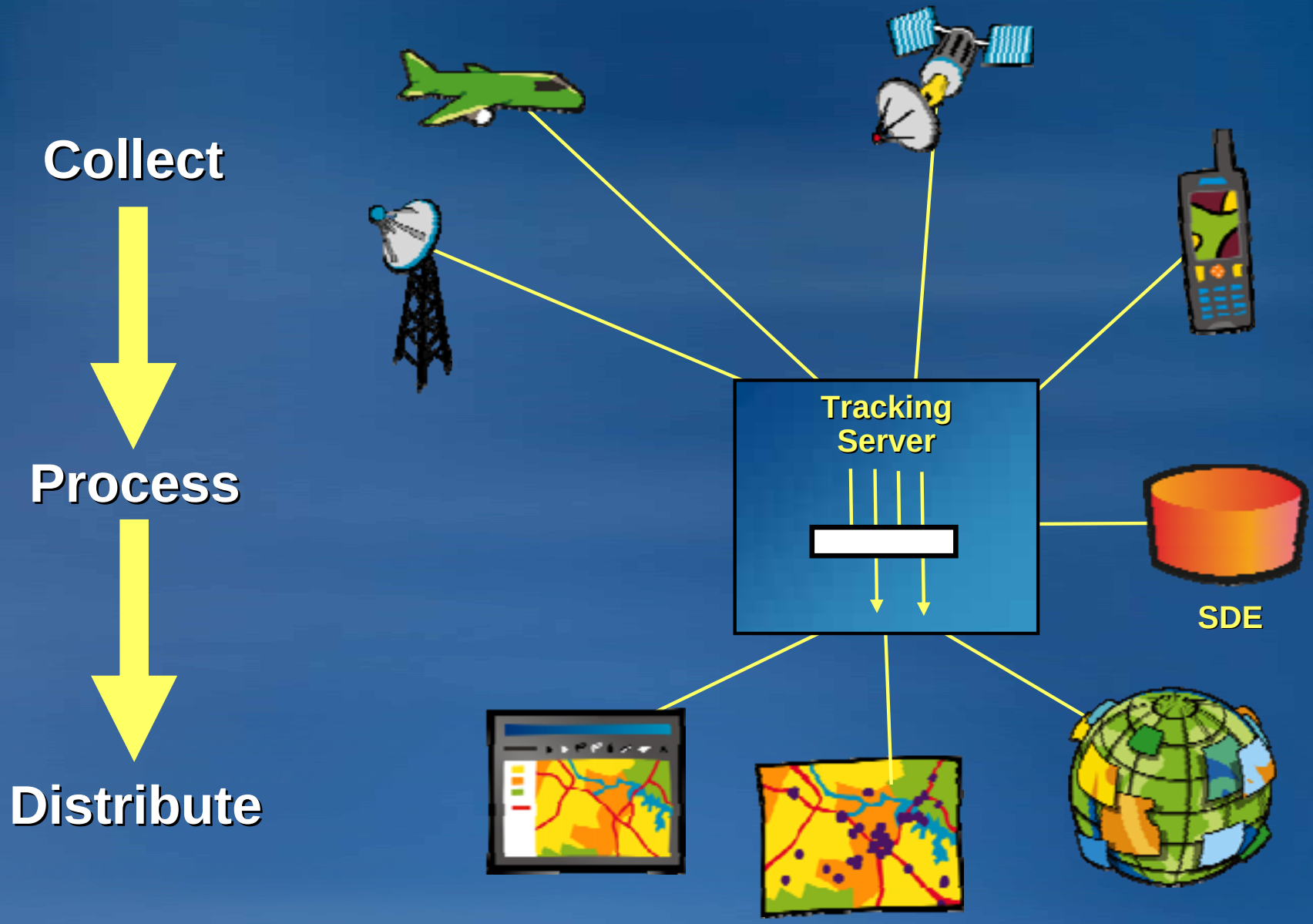
Animal Migration



Tracking Server

Tracking Server – Big Picture

Temporal Processing for GIS Data



Tracking Server Functions
Supporting Data Flow

- Collecting
  - Built-in Support for: XML, CSV
  - Any protocol can be supported through custom datalink development
  - Datalink & Connector SDK's for: C++, C#, Java
- Processing
  - "Actions" – framework to inspect or modify an observation
- Distributing
  - Tracking Clients subscribe to a named Tracking Service
  - Tracking Server pushes updates to subscribed clients
  - Web Client API's: Flash, Silverlight, Java
  - Desktop Client API's: C++, C#, Java (ArcGIS Engine)

Sensor Networks

Characteristics of a Sensor Network

- Low Power
  - Low cost / deployed in bulk (smart dust)
  - *Self organizing*, *fault-tolerant* network
  - Sensor location could be GPS linked, or set through surveying
- High end
  - Devices are targeted more for industrial or military use
  - Multi-sensor fusion in one device (may include GPS + compass)
  - Integrated with other systems (surveillance, control systems)

From low end to highly capable systems… sensors in a network usually share the communication responsibilities

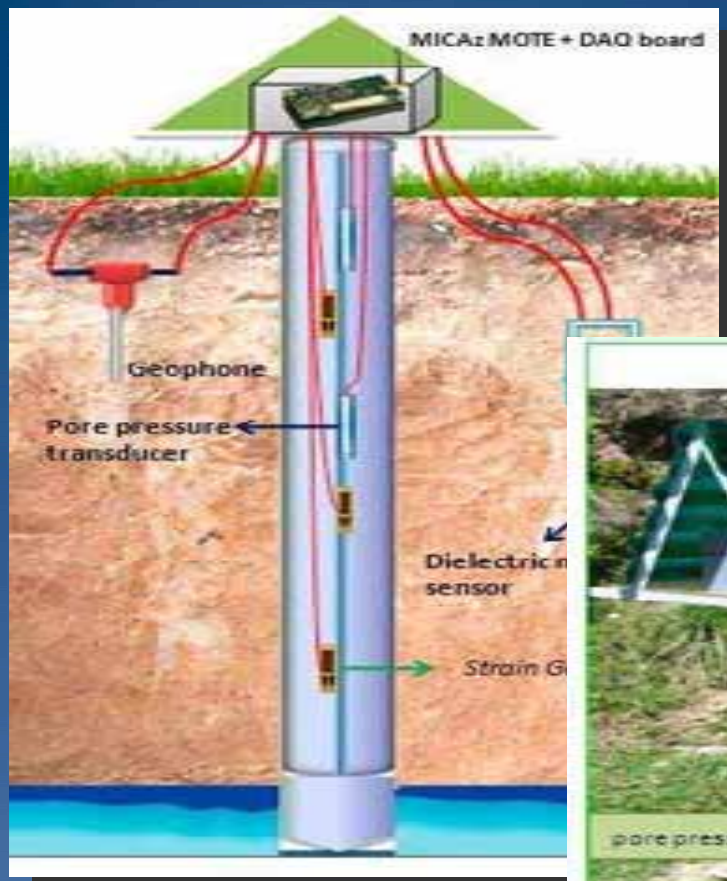
Networks of Small Scale - Connected at Larger Scale

National Science Foundation (nsf.gov) – NEON Project (neoninc.org)

Types of Sensors

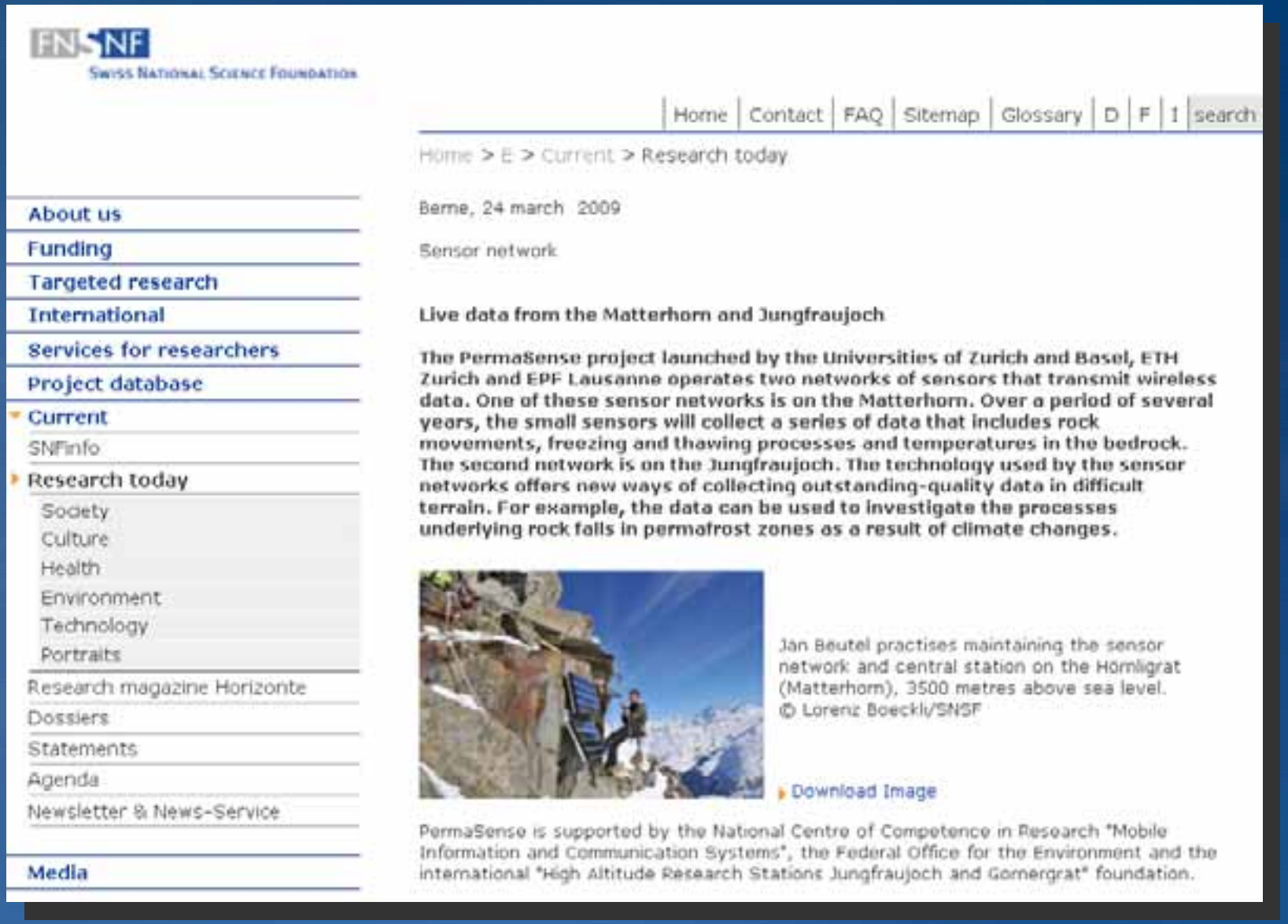
- Environmental
  - Sample-based: Wind, Precipitation, Temperature, Stream Gauges
  - Event driven: Lightning, Earthquakes
- Vehicles / Traffic
  - Event per vehicle – then processed into samples
- Specific Object Detection Systems
  - Event driven detection: Heat, Vibration, Motion
  - Electronic Signals: Radio, RFID
- Mobile Devices

Sensor Network Example – Detecting Landslides



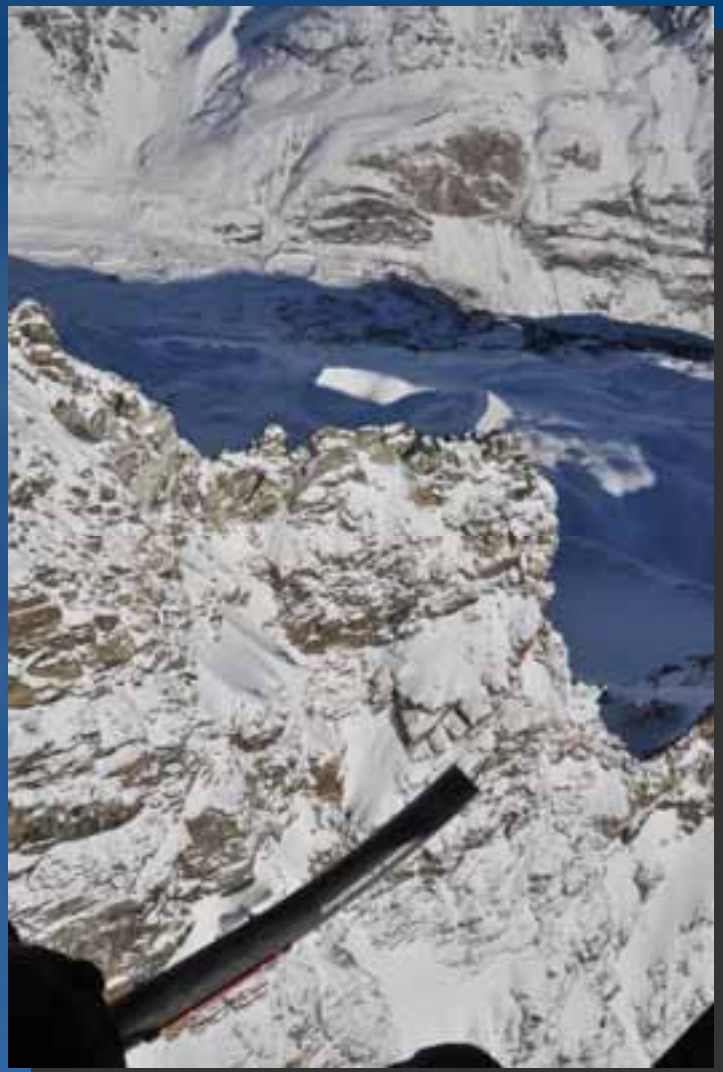
Amrita University - Munnar, Idukki, Kerala, India

Sensor Network Example – Bedrock Monitoring

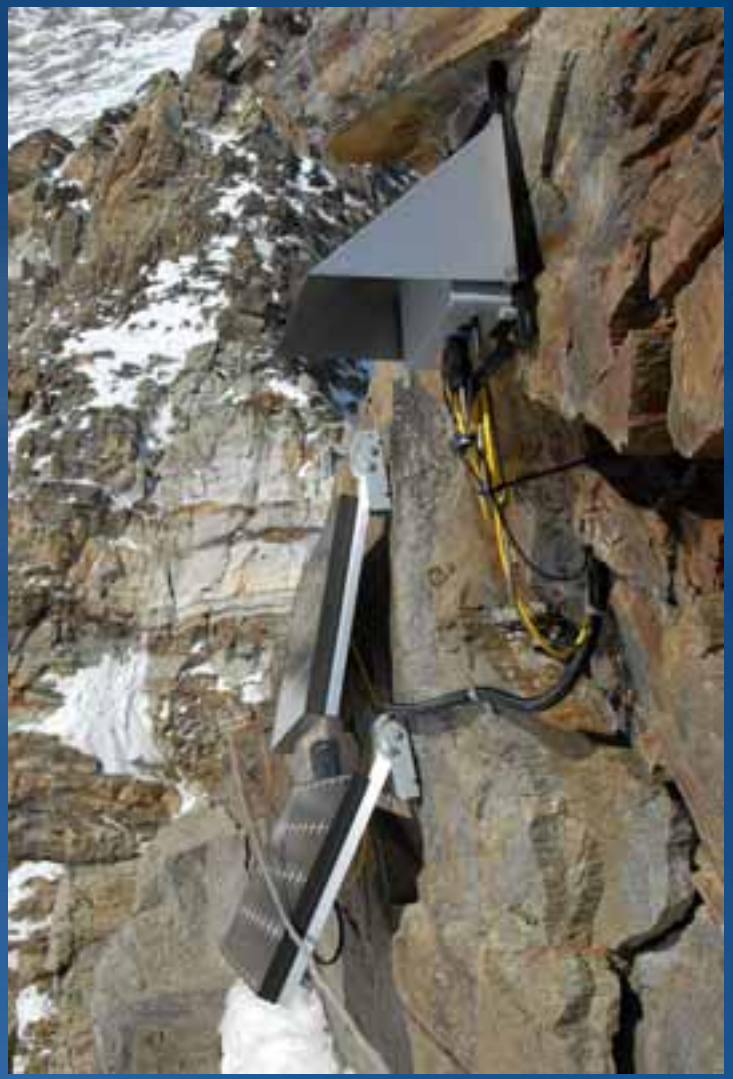


www.PermaSense.ch - Universities of Zurich and Basel & Swiss National Science Foundation

Sensor Network Example – Bedrock Monitoring



Sensor Network Example – Bedrock Monitoring



Sensor Network Example – Bedrock Monitoring

Auf dem Hörnligrat am Matterhorn, 3500 Meter über Meer, übt Jan Beutel Unterhaltsarbeiten am Sensometz und der Zentralstation aus.
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Sur l'arête du Hörnli au Cervin, à 3500 mètres d'altitude, Jan Beutel effectue des travaux de maintenance sur le réseau de nœuds capteurs et la s
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FNS NF
Fonds national suisse
Schweizerischer Nationalfonds
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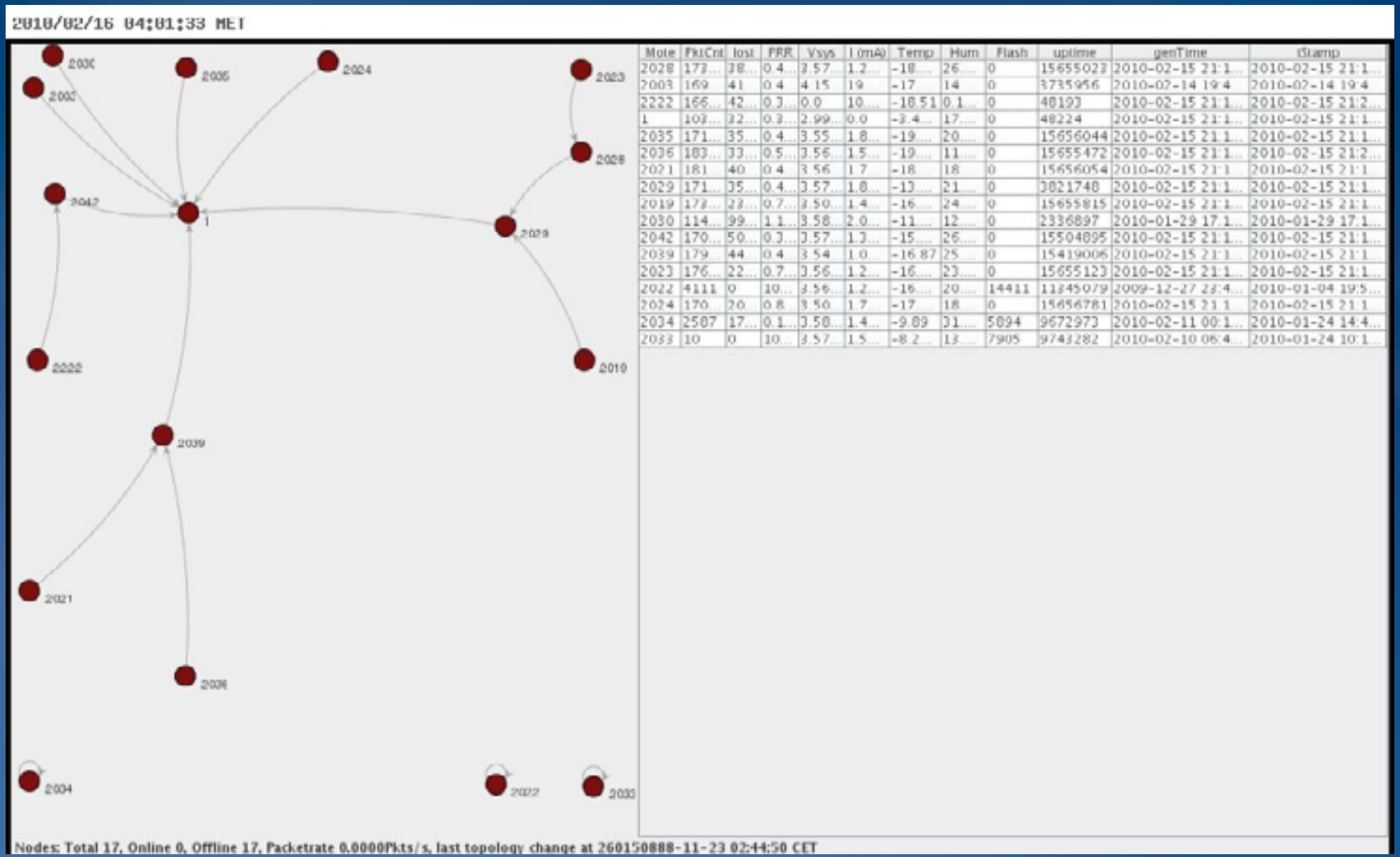
Sensor Network Topology – Matterhorn



Mote	PktCnt	lost	PRR	Vsys	I (mA)	Temp	Hum	Flash	uptime	genTime	tStamp
2028	173...	38...	0.4...	3.57...	1.2...	-18....	26....	0	15655023	2010-02-15 21:1...	2010-02-15 21:1...
2003	169	41	0.4	4.15	19	-17	14	0	3735956	2010-02-14 19:4	2010-02-14 19:4
2222	166...	42...	0.3...	0.0	10....	-18.51	0.1...	0	48193	2010-02-15 21:1...	2010-02-15 21:2...
1	103...	32...	0.3...	2.99...	0.0	-3.4...	17....	0	48224	2010-02-15 21:1...	2010-02-15 21:1...
2035	171...	35...	0.4...	3.55...	1.8...	-19....	20....	0	15656044	2010-02-15 21:1...	2010-02-15 21:1...
2036	183...	33...	0.5...	3.56...	1.5...	-19....	11....	0	15655472	2010-02-15 21:1...	2010-02-15 21:2...
2021	181	40	0.4	3.56	1.7	-18	18	0	15656054	2010-02-15 21:1	2010-02-15 21:1
2029	171...	35...	0.4...	3.57...	1.8...	-13....	21....	0	3021740	2010-02-15 21:1...	2010-02-15 21:1...
2019	173...	28...	0.7...	3.50...	1.4...	-16....	24....	0	15655815	2010-02-15 21:1...	2010-02-15 21:1...
2030	114...	99...	1.1...	3.58...	2.0...	-11....	12....	0	2336897	2010-01-29 17:1...	2010-01-29 17:1...
2042	170...	50...	0.3...	3.57...	1.3...	-15....	26....	0	15504895	2010-02-15 21:1...	2010-02-15 21:1...
2039	179	44	0.4	3.54	1.0	-16.87	25	0	15419006	2010-02-15 21:1	2010-02-15 21:1
2023	176...	22...	0.7...	3.56...	1.2...	-16....	23....	0	15655123	2010-02-15 21:1...	2010-02-15 21:1...
2022	4111	9	10...	3.56...	1.2...	-16....	20....	14411	1134979	2009-12-27 23:4...	2010-01-04 19:5...
2024	170	26	0.8	3.50	1.7	-17	18	0	15656781	2010-02-15 21:1	2010-02-15 21:1
2034	2507	17...	0.1...	3.50...	1.4...	-9.09	31....	5094	9672973	2010-02-11 00:1...	2010-01-24 14:4...
2033	10	0	10...	3.57...	1.5...	-8.2...	13....	7905	9743282	2010-02-10 06:4...	2010-01-24 10:1...

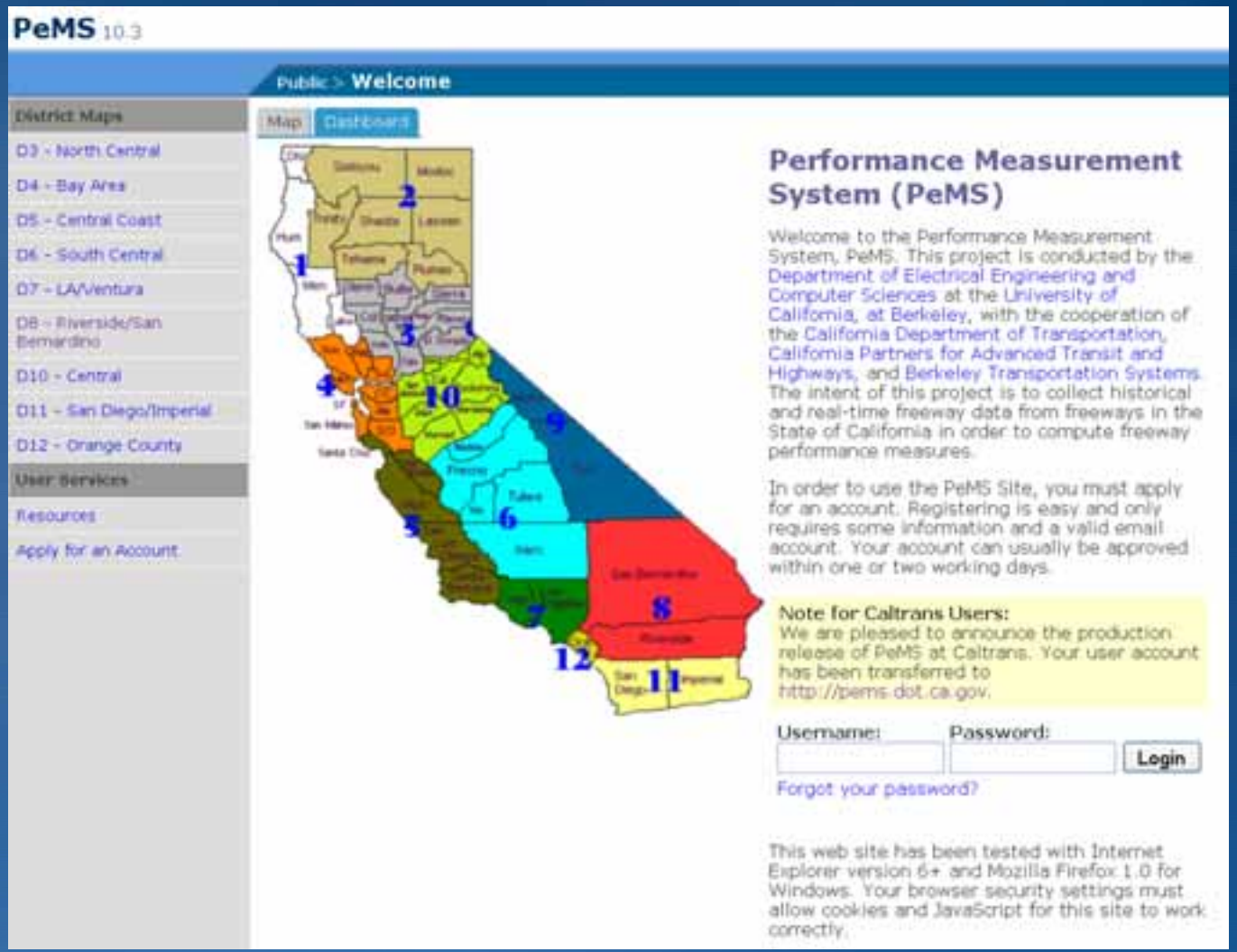
Sensor Network Data

- Matterhorn & Jungfraujoch
- Data collected approximately once per minute

- DEMO

Sensor Network Example – CalTrans Coverage Area

- Over 30,000 sensors in 10,000 locations
- Sensor pulses are collected every 5 sec.
- 30-second sum is reported regionally
- Each region reports to CalTrans



Sensor Network Example – Weather Stations

- APRS Protocol – “Amateur Packet Reporting System”
- Amateur Radio operators use this for 2-way text messaging
- Heavily used for weather beacon information

Analysis

Want to Learn More?

ESRI Training and Education Resources

- **Instructor-Led Training**
  - **Implementing Tracking Server**

http://www.esri.com/training

Questions?

- Please fill out the Session Survey form
- Thank You!