



GIS

The Geographic Approach for the Nation



ESRI Federal User Conference

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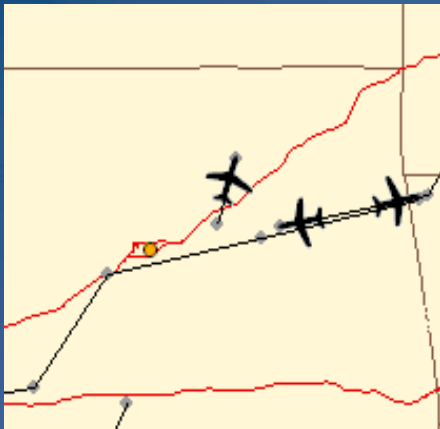
Tracking Solutions: Sensor Data Collections and First-Chance Analysis

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

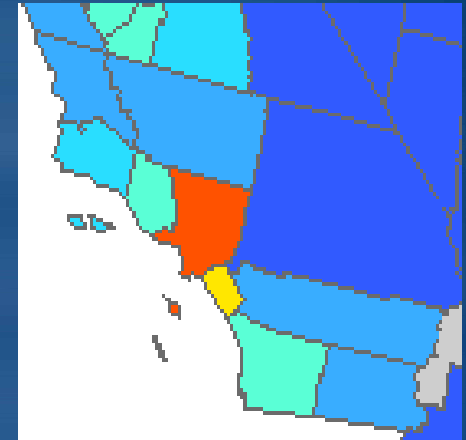
stands still but records changes



- Weather Stations
- Traffic Sensors

Change

change or growth



- Population
- Distribution

Time and Track Correlation

Time

Allows "Current" data to be shown

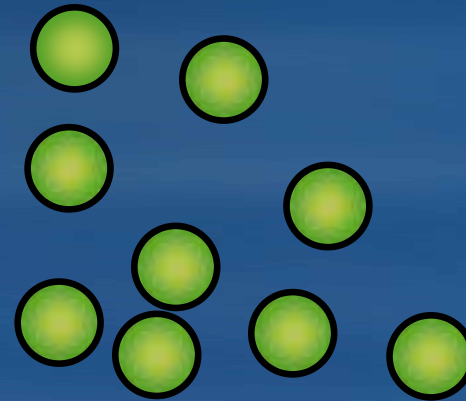


Traffic Accidents

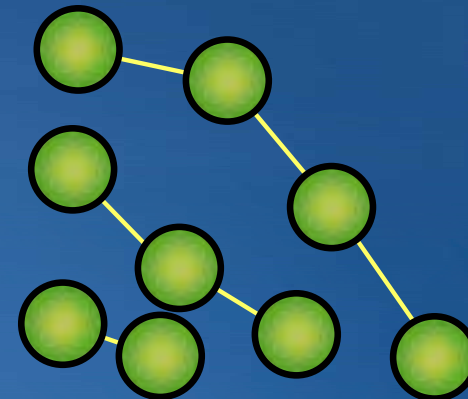


Correlation

Allows grouping by source



Animal Migration

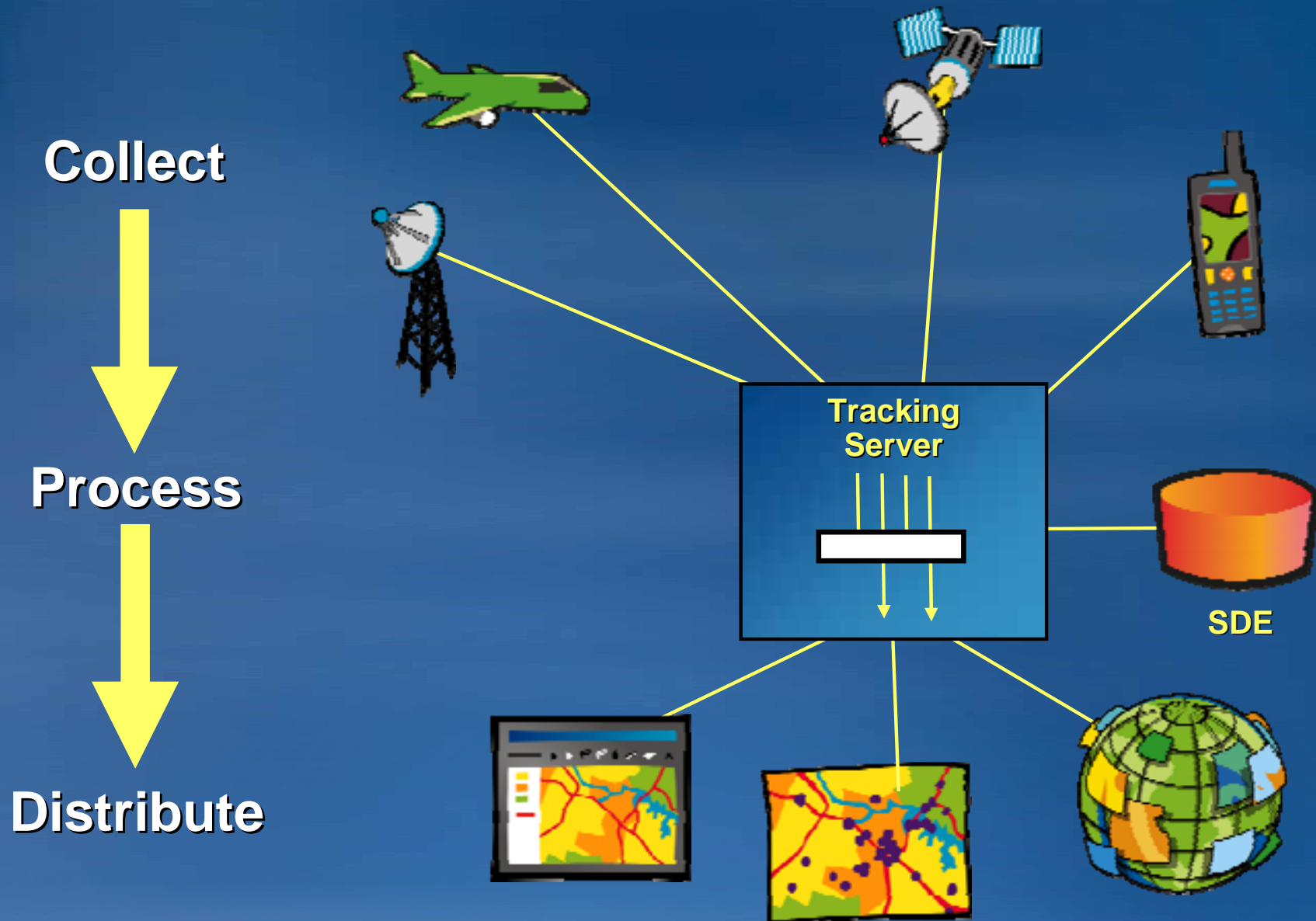




Tracking Server

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)



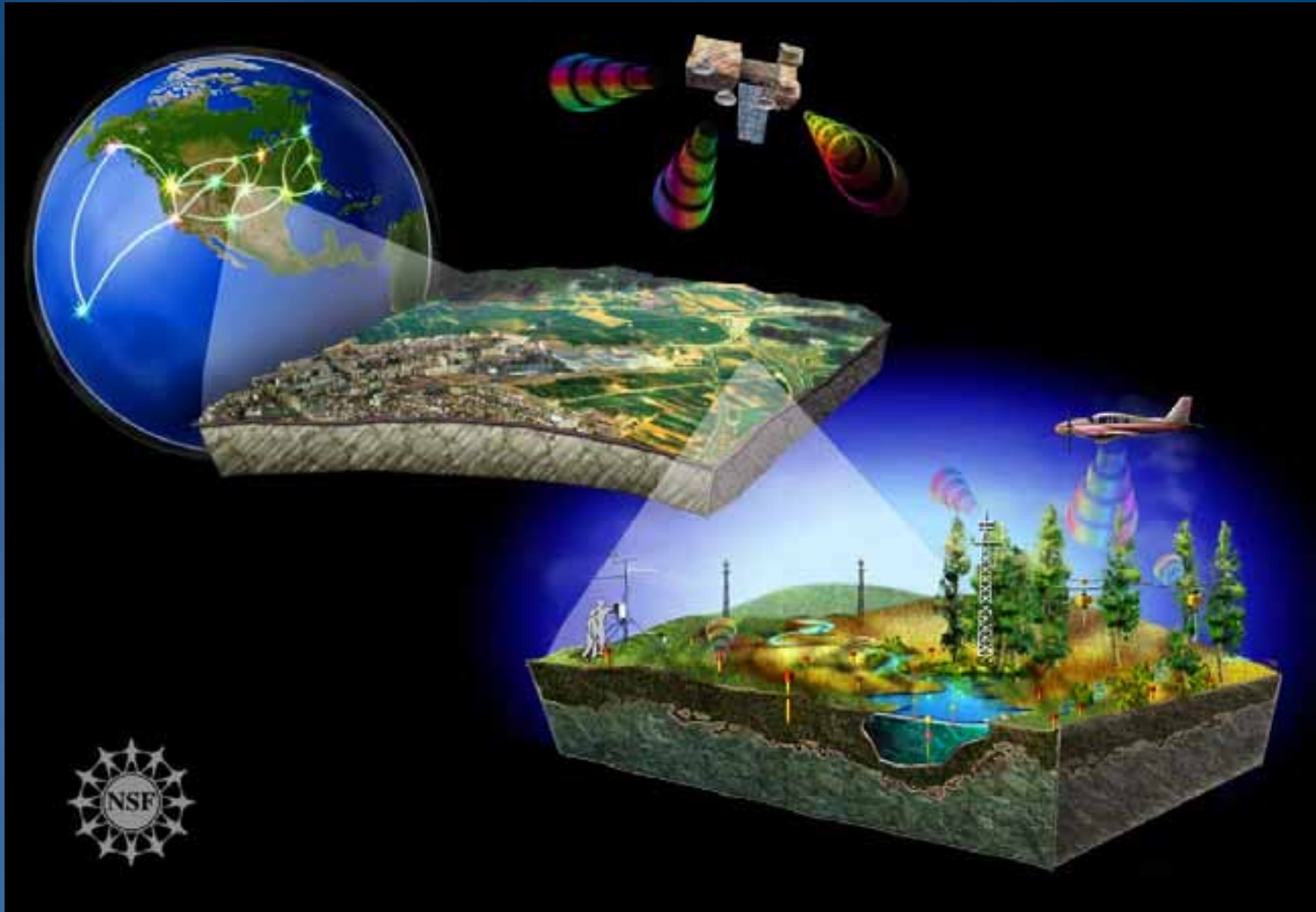
Sensor Networks

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

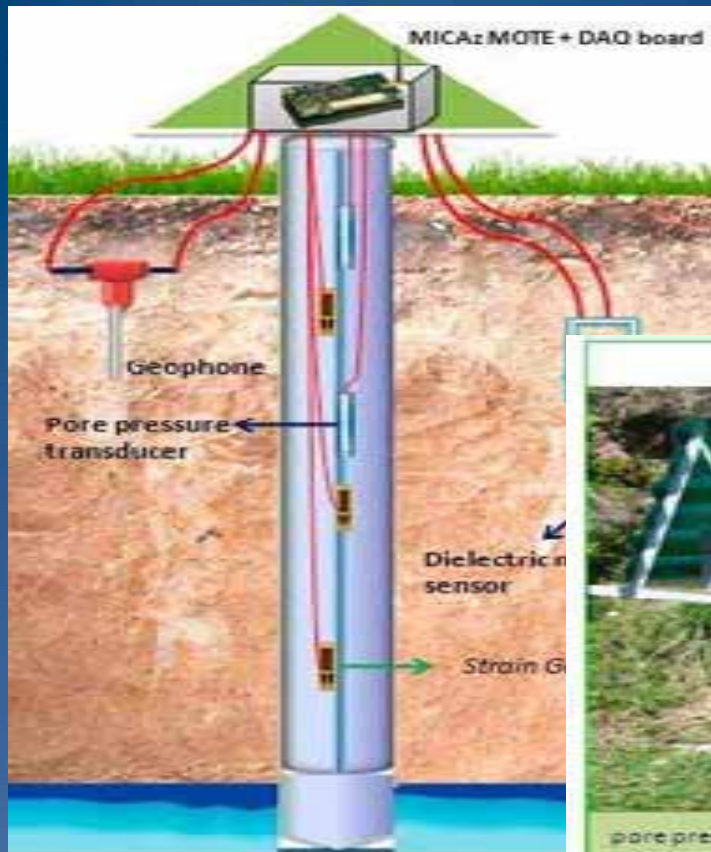


National Science Foundation (nsf.gov) – NEON Project (neoninc.org)


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



Sensor Network Example – Bedrock Monitoring


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Berne, 24 march 2009

Sensor network

Live data from the Matterhorn and Jungfrauoch

The PermaSense project launched by the Universities of Zurich and Basel, ETH Zurich and EPF Lausanne operates two networks of sensors that transmit wireless data. One of these sensor networks is on the Matterhorn. Over a period of several years, the small sensors will collect a series of data that includes rock movements, freezing and thawing processes and temperatures in the bedrock. The second network is on the Jungfrauoch. The technology used by the sensor networks offers new ways of collecting outstanding-quality data in difficult terrain. For example, the data can be used to investigate the processes underlying rock falls in permafrost zones as a result of climate changes.



Jan Beutel practises maintaining the sensor network and central station on the Hörnli Grat (Matterhorn), 3500 metres above sea level.
© Lorenz Boeckli/SNSF

[Download Image](#)

PermaSense is supported by the National Centre of Competence in Research "Mobile Information and Communication Systems", the Federal Office for the Environment and the international "High Altitude Research Stations Jungfrauoch and Gornegrat" foundation.

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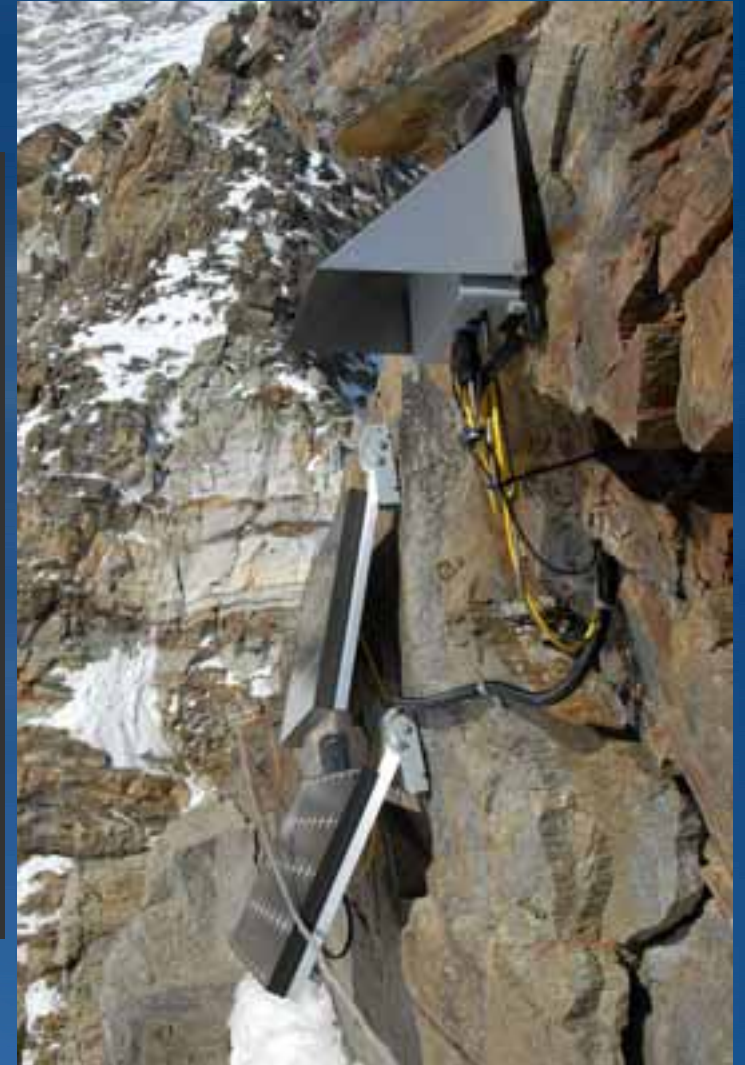
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Sensor Network Example – Bedrock Monitoring



Sensor Network Example – Bedrock Monitoring



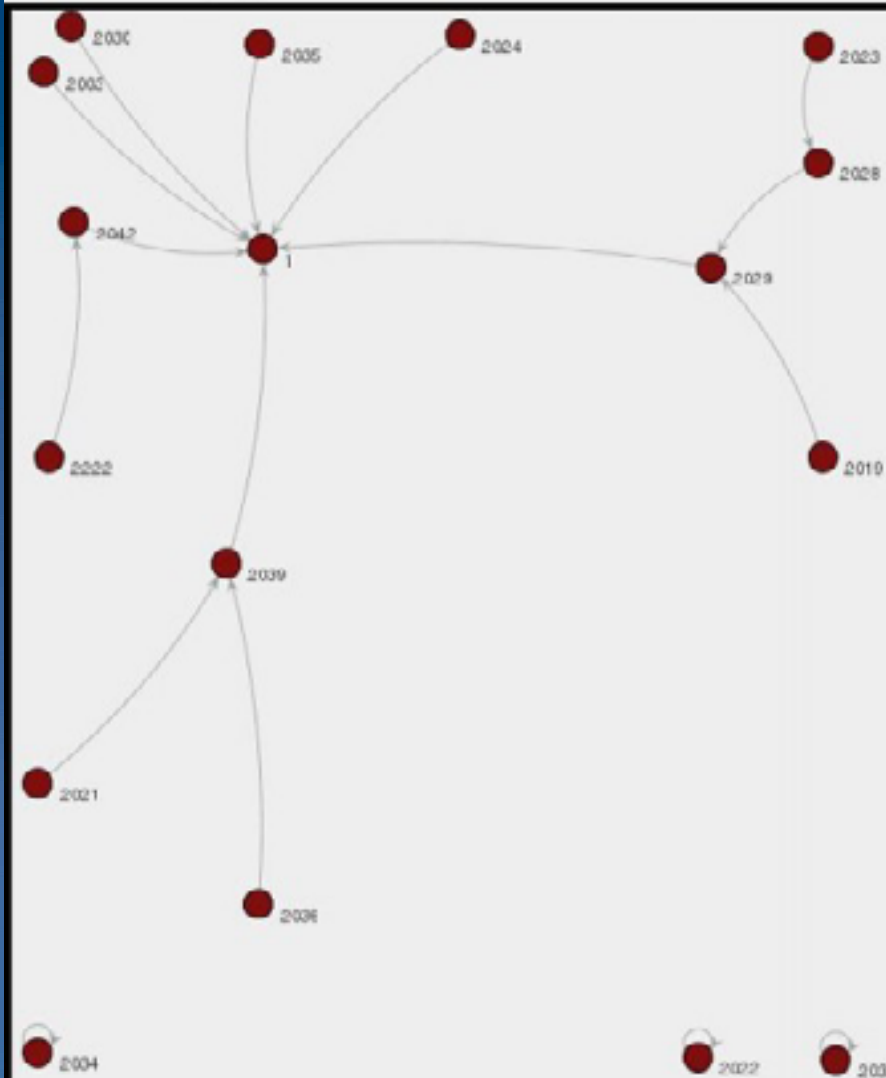
Sensor Network Example – Bedrock Monitoring



Auf dem Hörnigrat am Matterhorn, 3500 Meter über Meer, übt Jan Beutel Unterhaltsarbeiten am Sensornetz und der Zentralstation aus.
© Lorenz Boeckli/SNF
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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 station centrale.
© Lorenz Boeckli/FNS
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Sensor Network Topology – Matterhorn



Node	FkCnt	lost	PFR	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	3021748	2010-02-15 21:1...	2010-02-15 21:1...
2019	173...	23...	0.7...	3.59...	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	11345979	2009-12-27 23:4...	2010-01-04 19:5...
2024	170...	20...	0.8...	3.50...	1.7...	-17...	18...	0	15456781	2010-02-15 21:1...	2010-02-15 21:1...
2034	2587	17...	0.1...	3.50...	1.4...	-9.89...	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...

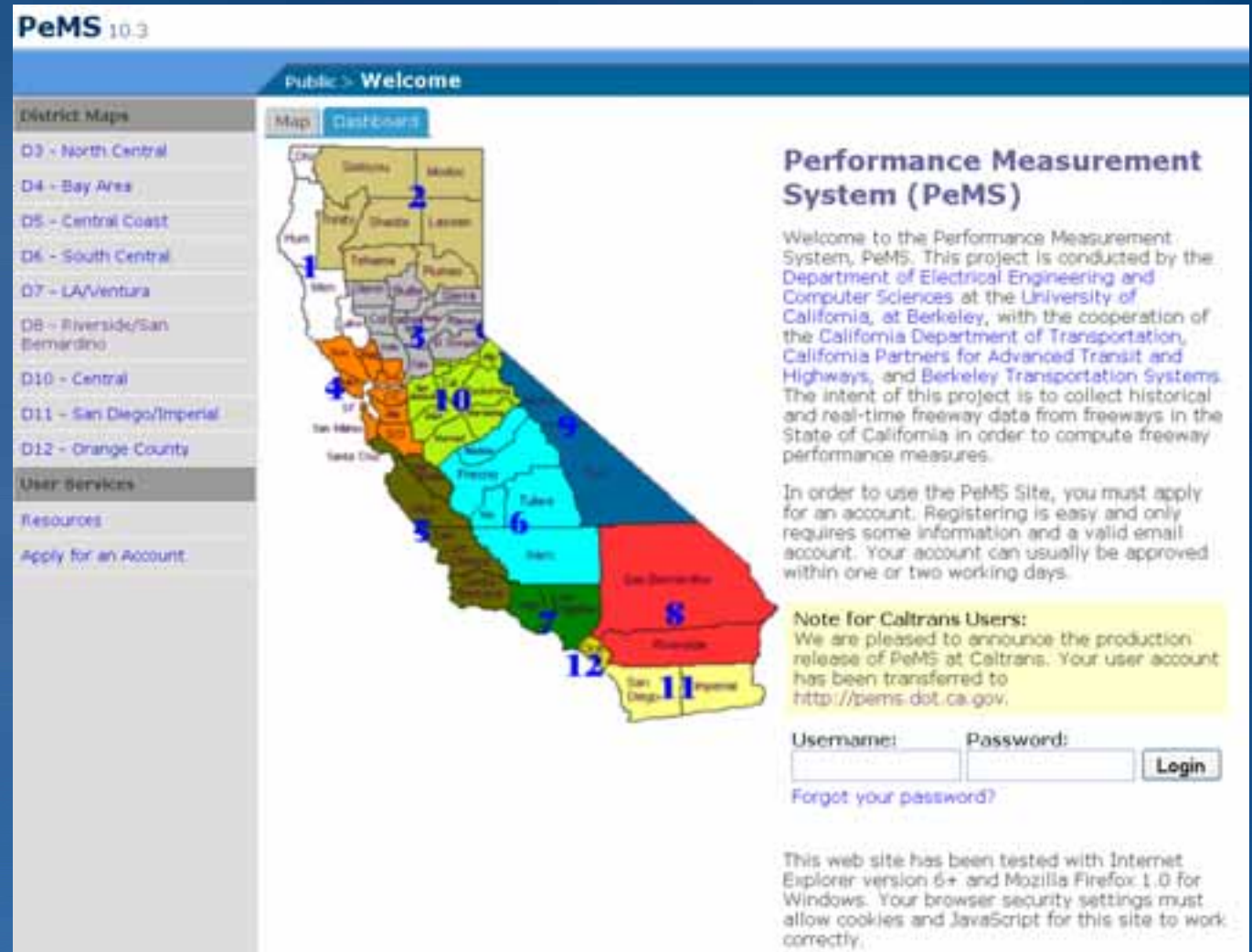
Nodes: Total 17, Online 0, Offline 17, Packetrate 0.0000Pkts/s, last topology change at 260150888-11-23 02:44:50 CET

Sensor Network Data

- Matterhorn & Jungfraujo
- 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!