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# Intelligent Safety Technologies to Drive Towards Zero Incidents

## Be aware, be proactive



Codelco Seminar in Calama – July 2012

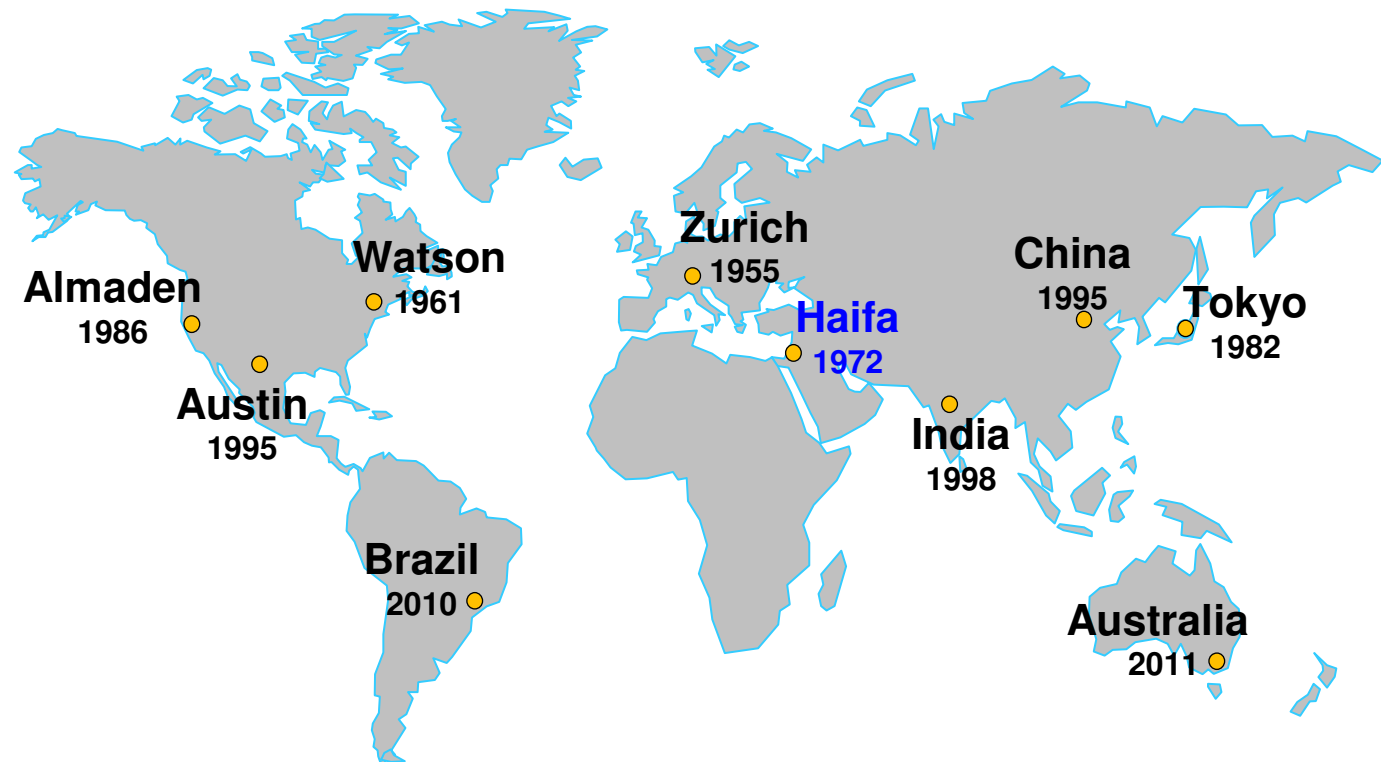
שלום

SHALOM



- Goal
- **Proactive Location Intelligence** – background and motivation
- Proactive Location Intelligence: description
  - Visual Analytics
  - Event Processing
  - Proactive Management
- **Safety (and more..) use-cases**
- **Scope of Work**
- **Research approach**
- **Roadmap**

# IBM Research



- 10 sites worldwide, ~3000 researchers
- Fundamental Research
- Differentiation for next-generation products, services and solutions

## IBM Research – Haifa

- Over 320 researchers
- IBM's largest research facility outside the US

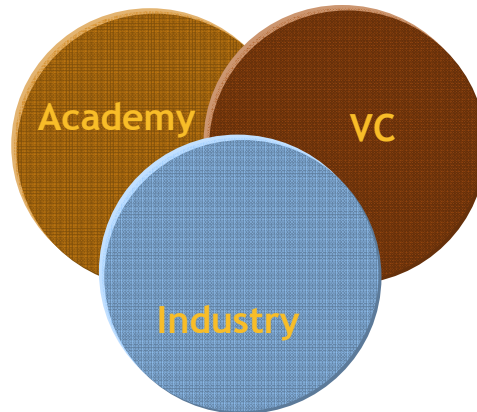


**Storage** **Cloud Computing** **Verification** **Distributed**  
**Middleware** **Software Development** **Event Processing**  
**Optimization technologies**, **Mobile Platforms**, **Collaboration**  
**and Social Networking** **Analytics** **Services** **Healthcare and Telco**  
**and more....**

# The Unique R&D Environment of Israel



- Top world class universities:
  - Technion, Hebrew University, Weizmann (Nobel and Turing awards)
  - Highest publications / capita



- \$1B VC investment in 2009
- In recent years ...
  - Over 250 companies sold through M&A
  - 100+ successful NASDAQ IPOs
  - 200 new start-ups established every year

- 3,000 technology companies
- 110 Israeli companies listed in NASDAQ - the second largest non-US country (after Canada)
- Over 80 Fortune 500 global corporations conduct leading edge R&D in Israel (IBM, Cisco, GE, Motorola, Philips, TI, SAP, EMC, ...) and in particular:
  - **Intel's** second largest design center; low power and wireless missions - in Israel
  - **Microsoft** has two R&D center with research focus, reaching 500 employees
  - **HP's** second largest R&D (due to acquisitions); a research center in the Technion
  - **Google** has two R&D center, **Yahoo!** has R&D center
- Israeli based leading companies: Checkpoint, Amdocs, Comverse, Nice, Orbotech, Zoran, Given Imaging...

# Goal

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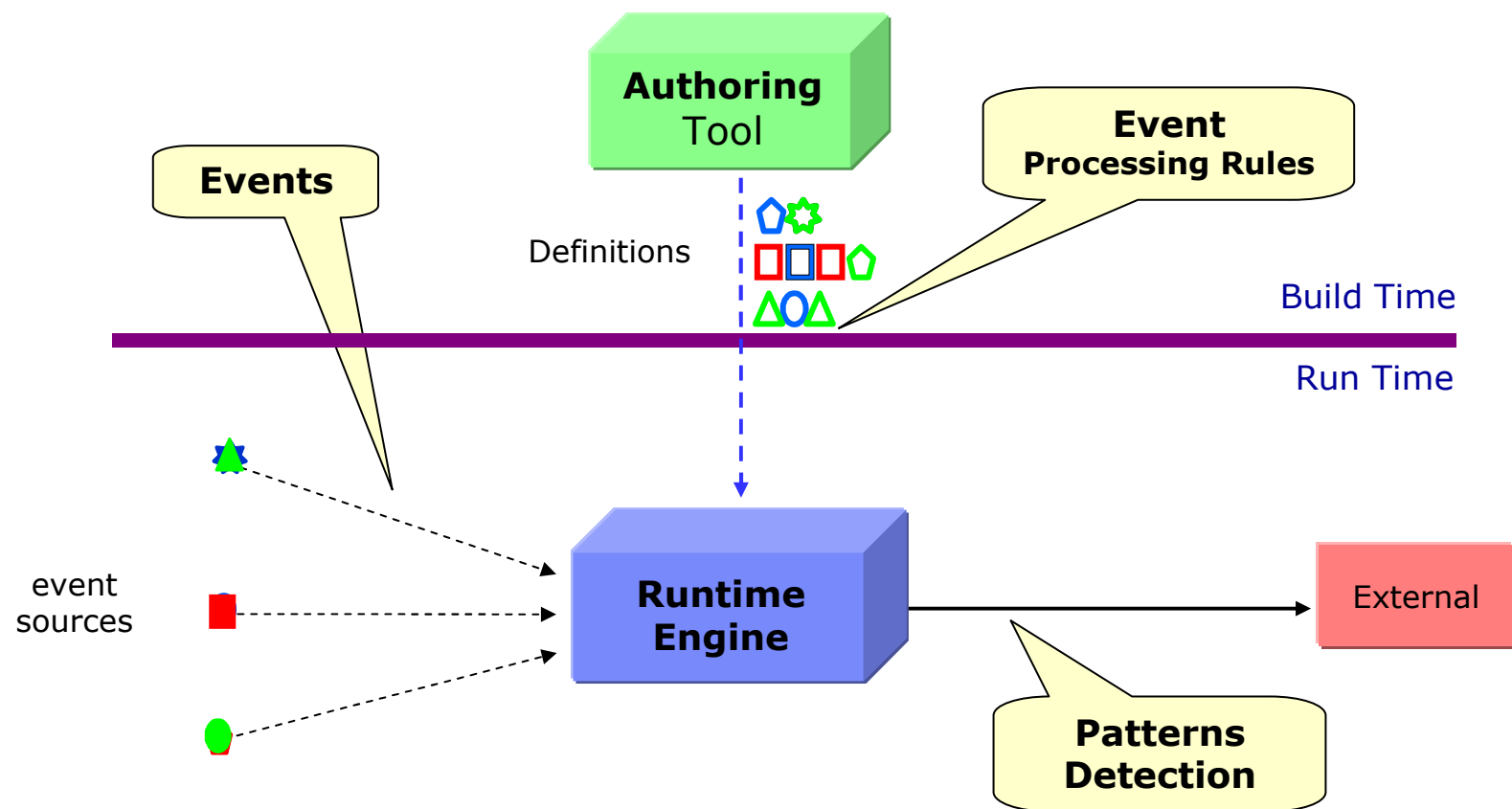
Increase **safety** and reduce operations risks by leveraging analytics and smart planet infrastructure such as sensors, GPS devices, Mobile devices and smart meters.

Specifically, discover safety patterns such as collision risk, entry to restricted zone, high temperature and pressure etc. and prevent risk by **alerting on potential safety events before they occur.**

## Where is all started ? Event Processing at Haifa Research Lab

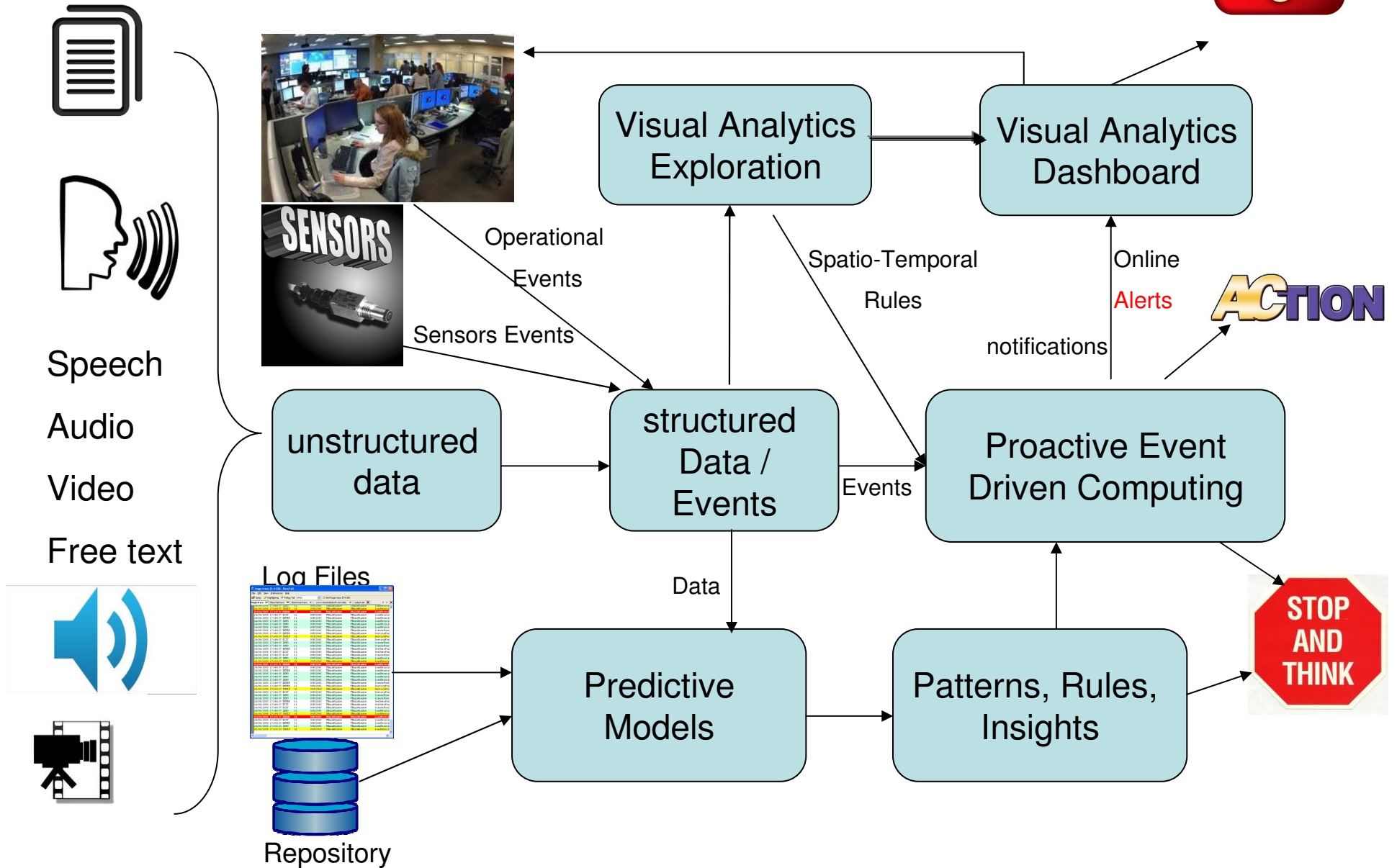
Events are us !

IBM Corporate Award and Outstanding Accomplishment for establishing Event Processing as an Emerging Market (based on AMiT - HRL Active Middleware Technology)

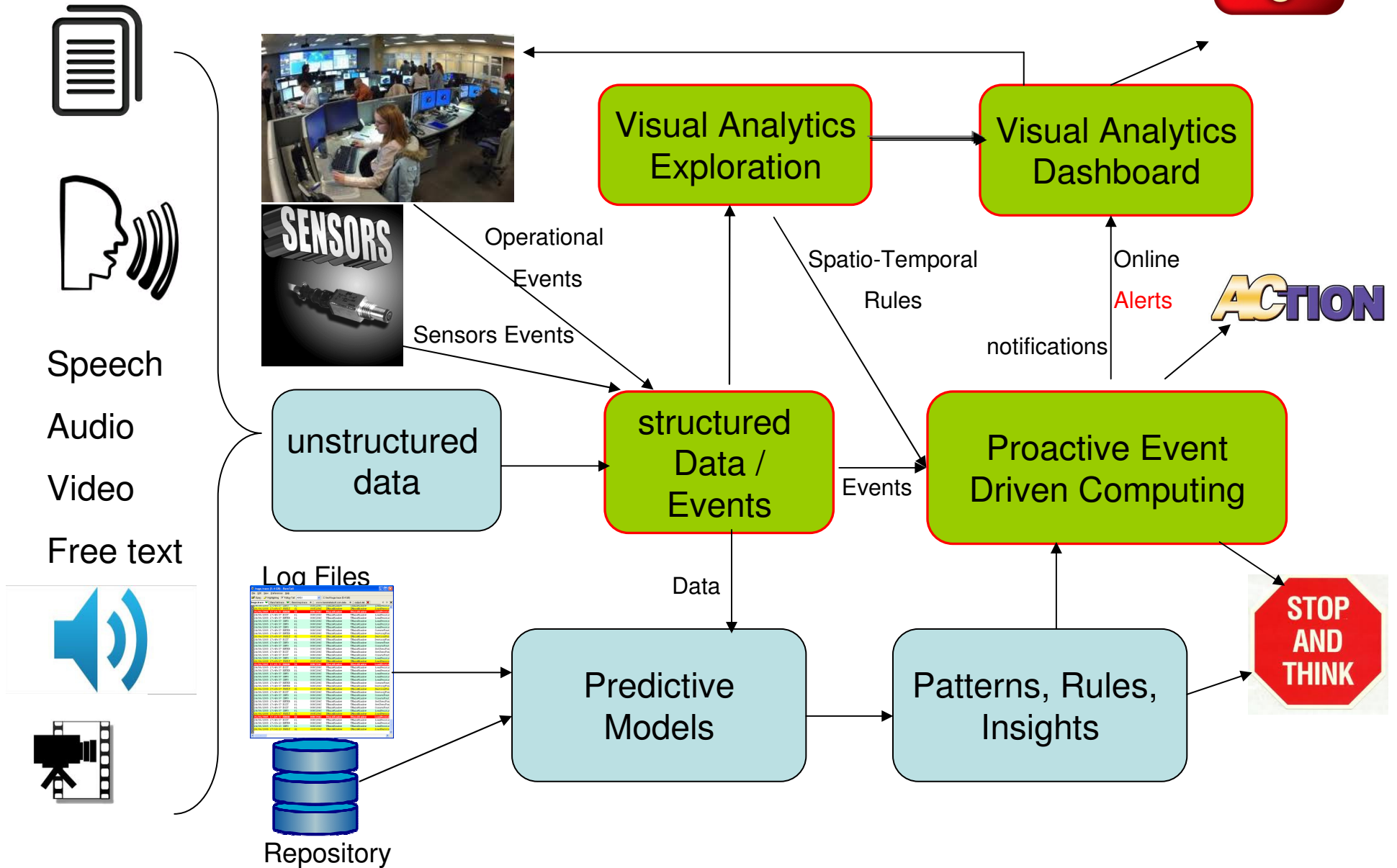




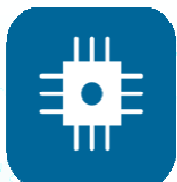
# High-Level Solution Components



# High-Level Solution Components



# Our world is getting smarter



*Our world is becoming*  
**INSTRUMENTED**



*Our world is becoming*  
**INTERCONNECTED**



*All things are becoming*  
**INTELLIGENT**



***Time and Location** are integral part of instrumented data  
**Events** are everywhere  
How can we leverage them to optimize our business ?*

# Understanding change in a dynamic world

Event is an instrumented signal indicating a change in the state of a physical object



Shipment delivered



Pressure reading



Temperature reading



Accident



Mobile devices



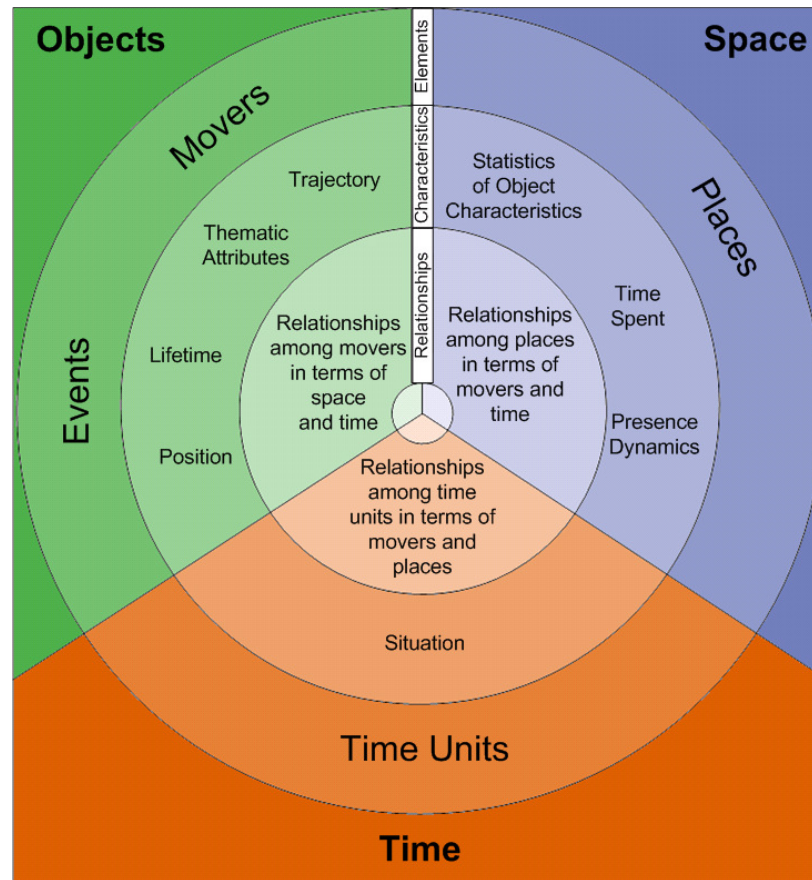
Crime event



GPS Signal

# Understanding change in a dynamic world

The event indicates the time and location of the object



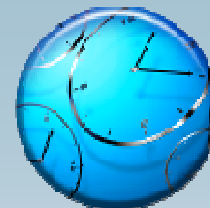
## Proactive Location Intelligence

### IBM Spatiotemporal Event Center



*Be aware*

Understand the  
dynamics of  
your operations



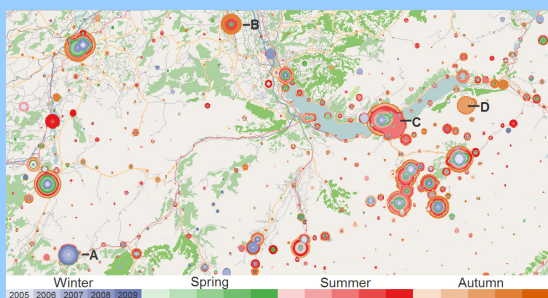
*Be proactive*

Smarter Actions  
ahead of Time

***For prevention, prediction, and  
optimization***

# IBM Spatiotemporal Event Center

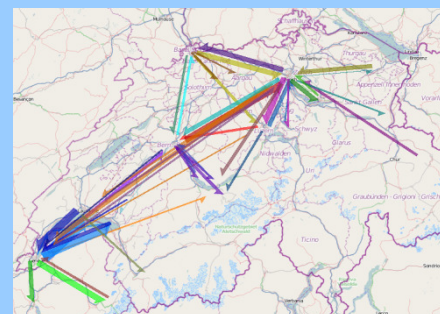
## Spatiotemporal Visual Analytics



Insight



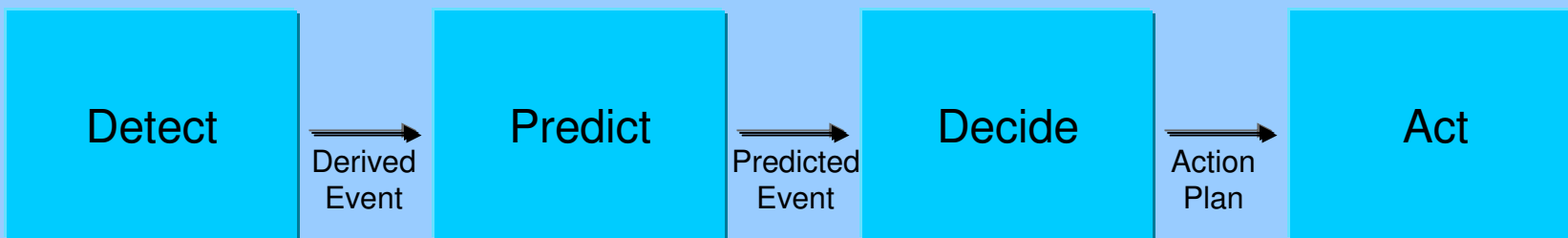
## Spatiotemporal Dashboard



Events  
(raw, derived & predicted)

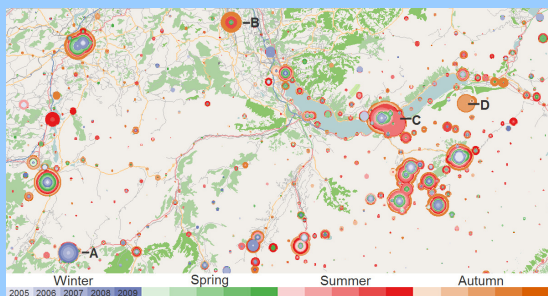


## Proactive Event Driven Computing

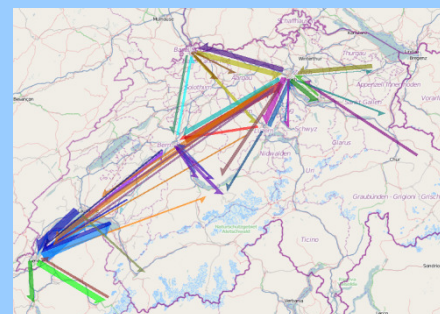


# IBM Spatiotemporal Event Center

## Spatiotemporal Visual Analytics



## Spatiotemporal Dashboard



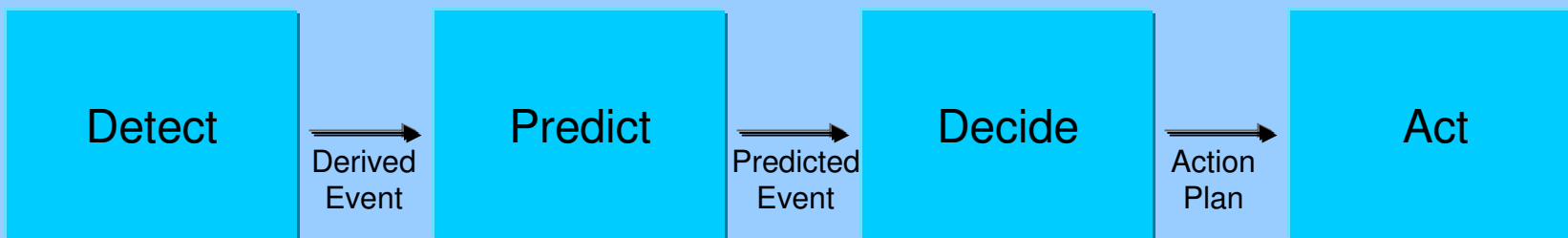
Insight



Events  
(raw, derived & predicted)



## Proactive Event Driven Computing







## The Power of Visualization

### Helsinki Public Transportation – Data in Excel

TrajID	Longitude	Latitude	Relative Time	Absolute Time	Lane Number	Direction	Vehicle ID
23	24.872565	60.19446	0.000004	08/11/2011 09:14	1004	2	RHKL00096
4	24.878807	60.19757	0.000004	08/11/2011 09:14	1004	2	RHKL00077
28	24.892807	60.208232	0.000004	08/11/2011 09:14	1010	2	RHKL00100
43	24.896835	60.20349	0.000004	08/11/2011 09:14	1010	2	RHKL00084
20	24.908427	60.20847	0.000004	08/11/2011 09:14	1059	1	EFENG1061000195
12	24.911293	60.191222	0.000004	08/11/2011 09:14	1004	1	RHKL00089
17	24.918607	60.188108	0.000004	08/11/2011 09:14	2194	2	EFENG1061000067
34	24.91897	60.187542	0.000004	08/11/2011 09:14	1010	2	RHKL00045
21	24.918998	60.18783	0.000004	08/11/2011 09:14	1010	1	RHKL00083
2	24.919233	60.18748	0.000004	08/11/2011 09:14	1010	2	RHKL00068
19	24.920188	60.186615	0.000004	08/11/2011 09:14	2194	1	EFENG1062200066
35	24.920287	60.189602	0.000004	08/11/2011 09:14	1007B	2	RHKL00044
5	24.92122	60.18584	0.000004	08/11/2011 09:14	1004	1	RHKL00076
32	24.923957	60.183985	0.000004	08/11/2011 09:14	1010	1	RHKL00043
6	24.926535	60.191798	0.000004	08/11/2011 09:14	1003B	2	RHKL00075
3	24.930117	60.192535	0.000004	08/11/2011 09:14	1003T	2	RHKL00070
38	24.931813	60.184263	0.000004	08/11/2011 09:14	1008	2	RHKL00217
31	24.934498	60.198162	0.000004	08/11/2011 09:14	1007A	2	RHKL00238
10	24.934713	60.198382	0.000004	08/11/2011 09:14	1007B	2	RHKL00209
9	24.939353	60.185733	0.000004	08/11/2011 09:14	1008	1	RHKL00207
39	24.940378	60.185915	0.000004	08/11/2011 09:14	1008	1	RHKL00219
36	24.944315	60.200682	0.000004	08/11/2011 09:14	1007A	2	RHKL00212
37	24.944715	60.209902	0.000004	08/11/2011 09:14	1001A	1	RHKL00215
0	24.945373	60.203487	0.000004	08/11/2011 09:14	1001	2	RHKL00038
29	24.946685	60.190158	0.000004	08/11/2011 09:14	1003B	2	RHKL00221
27	24.947532	60.19432	0.000004	08/11/2011 09:14	1059	1	EFENG1060400457
16	24.948222	60.189428	0.000004	08/11/2011 09:14	1001A	1	RHKL00053
25	24.948572	60.186737	0.000004	08/11/2011 09:14	1001	2	RHKL00239
40	24.950278	60.181395	0.000004	08/11/2011 09:14	1001	2	RHKL00049

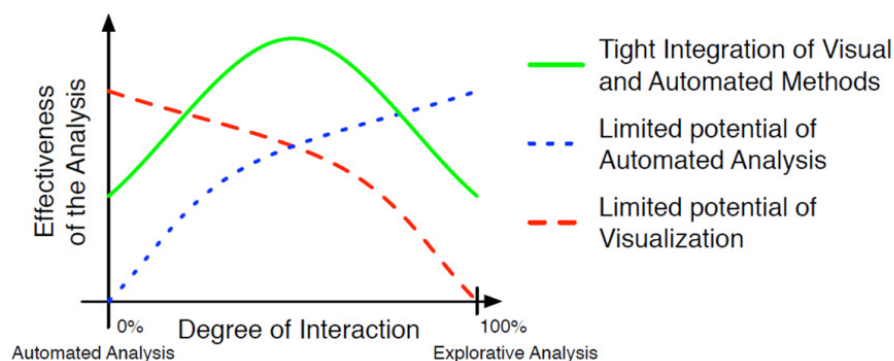
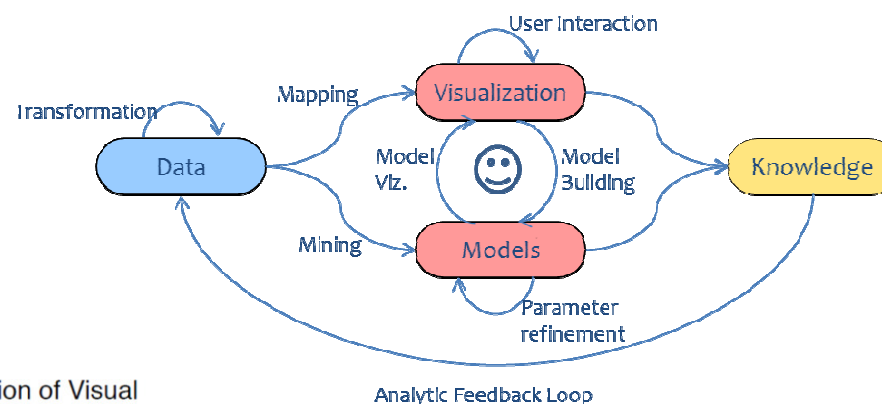
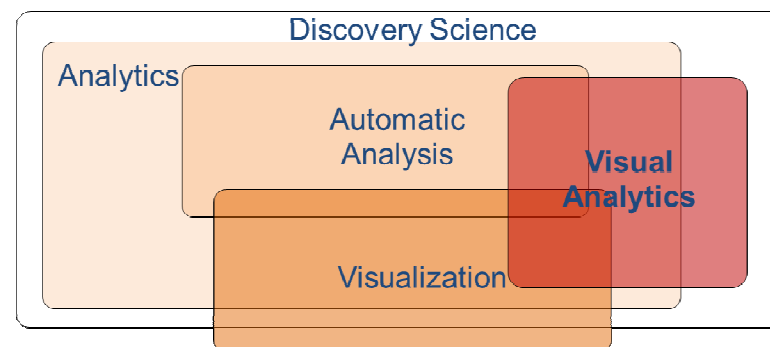
# The Power of Visualization

## Helsinki Public Transportation – Data visualized on map



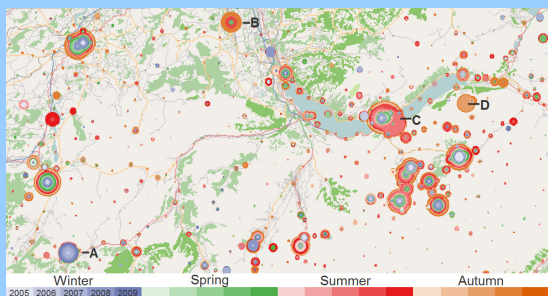
## Visual Analytics – an approach for interactive discovery

- Visual Analytics aims at extracting information from large data sources.
- ... when automatic analysis is not effective enough
- ... by relying on the human capabilities (perception and domain knowledge) to generate new hypotheses
- ... via smart combination of automatic algorithms and interactive visualization



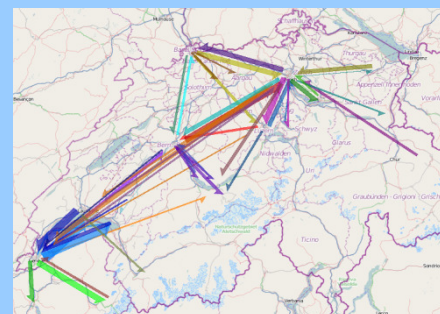
# IBM Spatiotemporal Event Center

## Spatiotemporal Visual Analytics



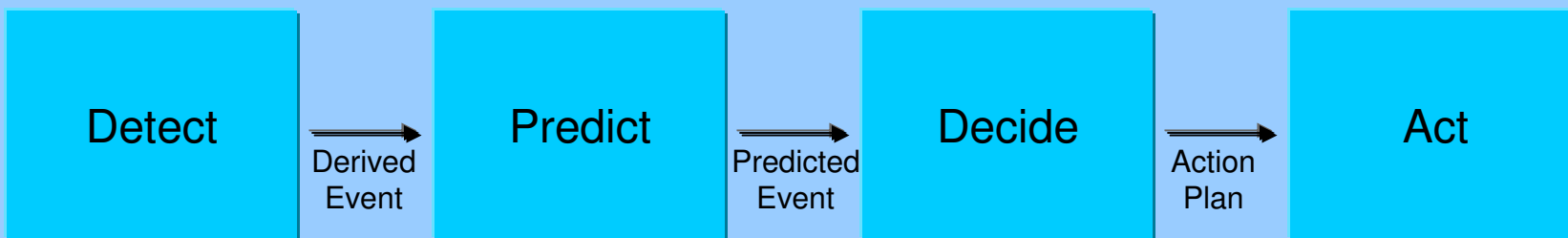
Insight

## Spatiotemporal Dashboard



Events  
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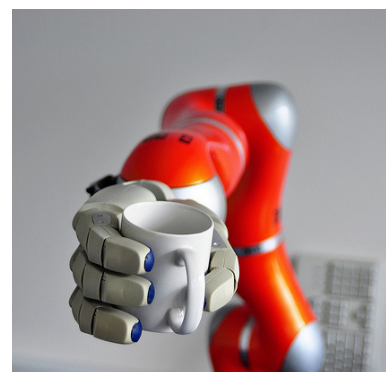
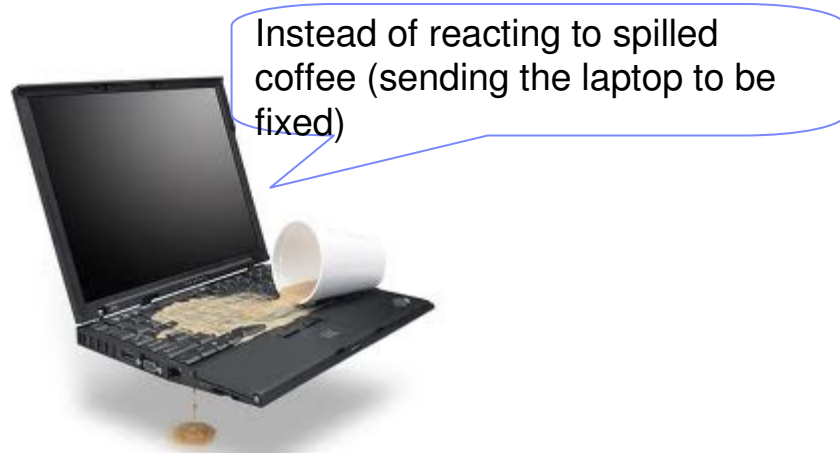
## Proactive Event Driven Computing



## The Proactive Society

“A **clever** person can get out of situations from which a **smart** person never gets in”

- ❑ It is cheaper and more effective to tackle a problem before it occurs than to resolve it once it occurs
- ❑ With the growth in the role of automation, the responsibility of eliminating problems shifts from the human to a computer and creates a new era of computing



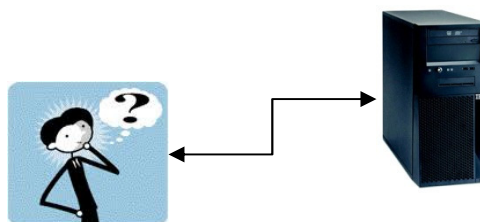
- “Passively waiting until a plan is missed or customers complain is an expensive way to solve the problem and is increasingly risky to the brand and reputation of a business, particularly when prevention and problem optimization can be designed into the process.”

*Maureen Fleming  
IDC*

# The Evolution Towards Proactive Event-driven Computing

## Past

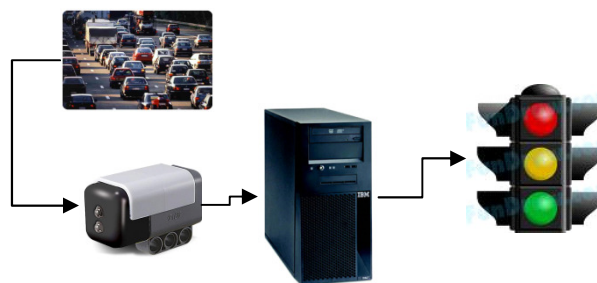
Typically people employ computing in **responsive** way: the person makes decisions and the computer assists in data, knowledge, advice



*The initiative remains in human hands; most persons are not proactive by nature*

## Today

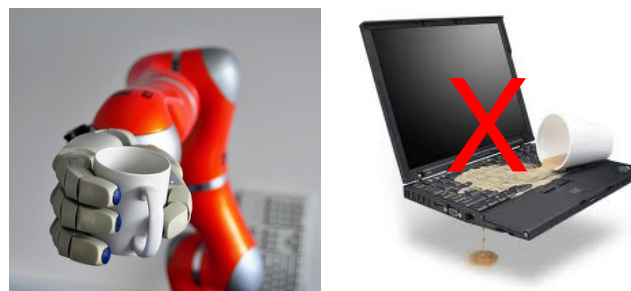
Recently, there is more employment of computers in **reactive** way: events drive decisions (Detect-Derive-Decide-Act)



*The initiative moves to the computer; reactions to events that already occurred*

## Tomorrow

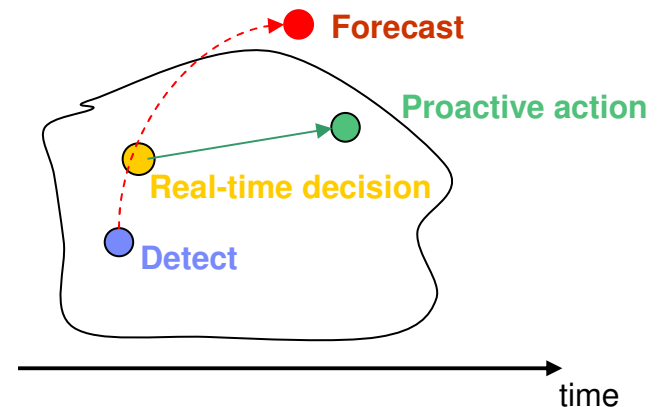
The vision is to move to **proactive** computing: (Detect-Derive-Predict-Decide now-Act)



*The initiative moves to the computer; actions to events before they occur*

# Proton – IBM Proactive Technology Online

*A Proactive event-driven Computing System*

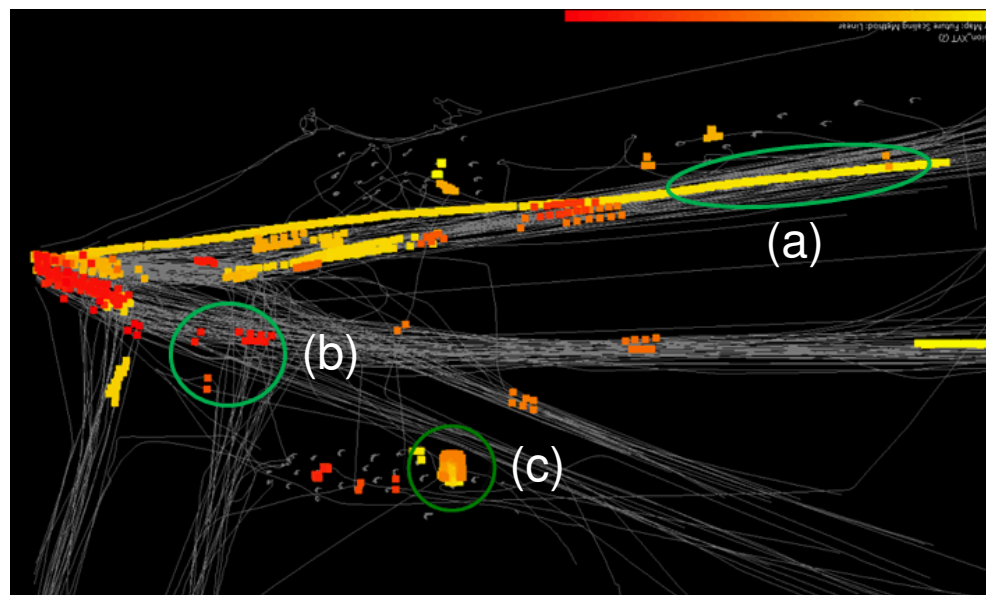


- **WHAT Proton does**
  - **Detect** events and situations based on observations on the operational system and exogenous events
  - **Forecast** future events and states (where the operation is going to)
  - **Decide**, within time constraints, how to handle these predictions
  - **Act** by adapting (e.g., re-plan/optimize) the operational system to eliminate/mitigate the undesired state OR to reach the desired states (in case of opportunity)
  
- **HOW Proton does it**
  - **Single** model (*detect-predict-decide-act*) and User Interface for creating a proactive application
  - **Integrated** (*detection-prediction-decision-action*) run-time platform to **develop**, **deploy** and **maintain** proactive applications



## Use case 1: Safety - Visual Analytics of Collision Risk

- Color dots show trucks getting too close to each other
  - Color is mapped to time:
- Finding 1: most near-collisions occur in the afternoon. This is true also in the "natural bottleneck" of the main mining area
- Finding 2: three different types of near-collision occurrences:
  - a. One truck follows the other
  - b. Crossing of trajectories – collision risk in evening hours
  - c. One truck moves around the other in the parking / top circle...



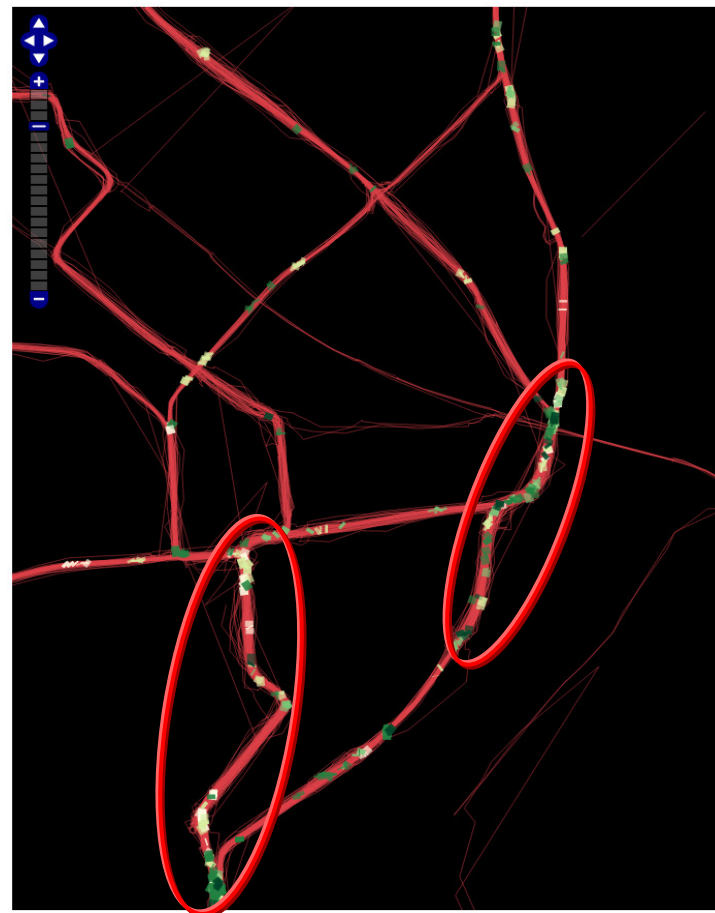
## Use case 1 (cont): Safety - Proactive Event Driven Prevention of Collisions

- Detect safety patterns identified by the visual analytics component
  - Two trucks are on a collision course
  - Restricted zone entry
  - Too many people in a risk area
  - Allow only authorized personal near the equipment
  - ....
- Predict if a collision is going to happen based on real time data
- Decide on an action plan
  - Alert to drivers
  - Automatic stop of vehicles for two minutes
- Highlight safety event on the dashboard for real time monitoring and future analysis



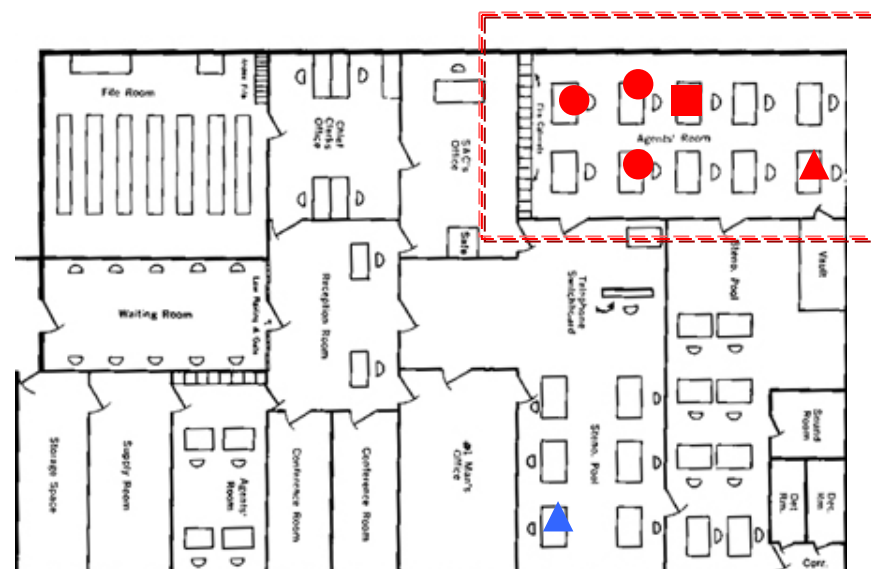
## Use Case 2 – Preventive Maintenance Visual Analytics of Asset Conditions (Moving Assets)

- Allow asset managers, controllers and maintenance officers to discover and understand the dynamics of their assets, optimize maintenance, and reduce unplanned maintenance.
- Discover correlation between vehicle faults to routes, type of vehicle, delivered goods, weather conditions, driving characteristics, and other parameters.
- Color dots show anomalous sensor readings on trucks (e.g. engine temperature, wheel pressure, ...)
- Finding (for example): most anomalous sensor readings occur in long curve-reach routes, with max-load.



## Use Case 2 (Cont) – Preventive Maintenance Visual Analytics of Asset Conditions (Fixed Assets)

- Visually discover correlation between anomalous sensor readings, type of equipment, and equipment location
- Color dots show anomaly sensor readings (e.g. high temperature reading, high pressure reading)
- Color mapped to severity, shaped mapped to asset type
- Finding: In the highlighted area – several high temperature readings in different types of equipment - may indicated a problem in air-conditioning



## Use Case 2 (cont) – Preventive Maintenance Proactive Event Driven Maintenance of Assets

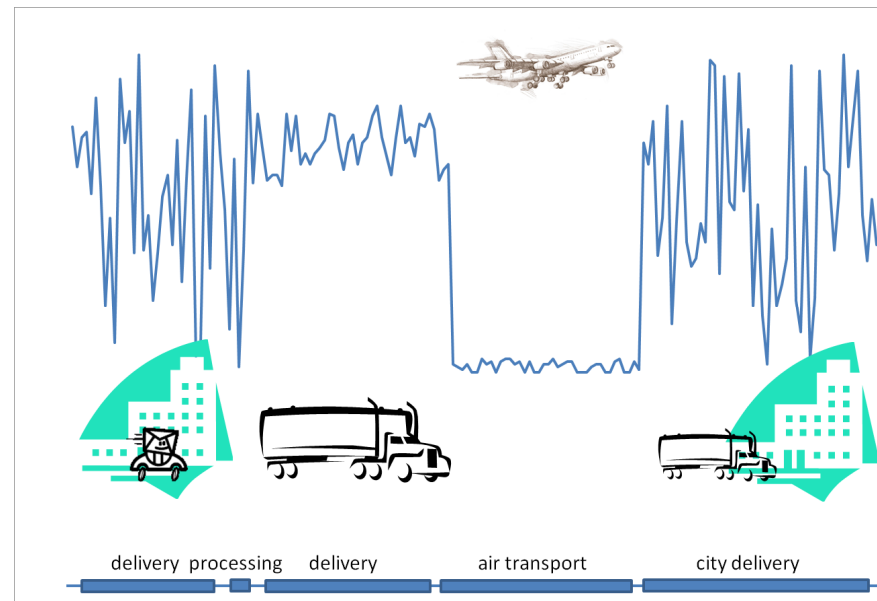
- Detect asset condition patterns identified by the visual analytics component
  - Indication of high load and pressure, undesired weather condition and route includes rowdy segments
- Predict if a malfunction of the asset is going to happen based on the real time data
- Decide on an action plan for prevention
  - Alert to drivers
  - Automatic reduction of speed, choose a different route
  - Schedule for earlier and specific maintenance
- Highlight condition or malfunction events as well as the consequences of the real time decision on the dashboard for real time monitoring and future analysis



## Use Case 3 – Managing Deviations in Transport Logistics

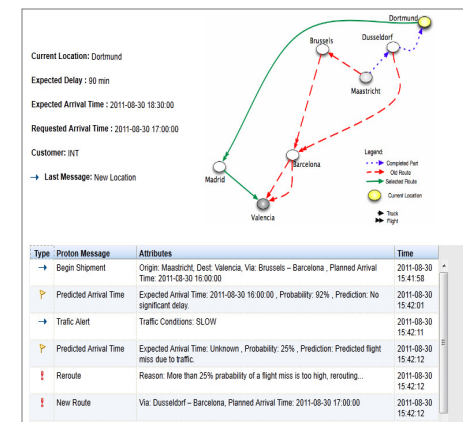
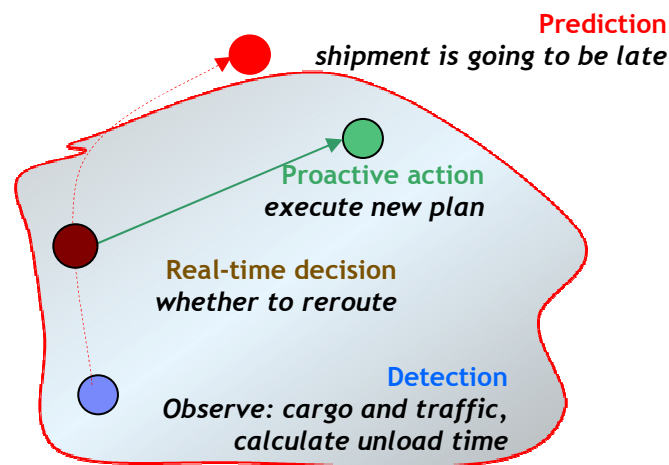
### Visual Analytics of Deviation from Plan

- Bring raw sensor data, delaying events, and other supporting data into visualizations that are comprehensible to a mining operations analyst.
- Using interactive explorations and analyses, the analyst can generate and validate various hypotheses relating to route optimization, causes for deviations in plan, etc.
- Examples:
  - Impact of cargo loads at certain locations at certain times on delays
  - Planned vs. actual routes - visualize routes to identify outliers that impact delays
  - Understand where goods are delayed and how they are transported



## Use Case 3 (cont)– Managing Deviations in Transport Logistics Proactive Event Driven Rescheduling to Stay on Track

- Detect delay patterns identified by the visual analytics component
  - Indication of cargo loads, high concentration of traffic on routes, deviation from planned routes
  - ....
- Predict if a delay in plan is going to happen based on the real time data
- Decide on an action plan
  - Alert operation controllers
  - Automatic redirection and local re-planning to bring the operation back on track
- Highlight deviation event as well as the consequences of the real time decision on the dashboard for real time monitoring and future analysis



## Research Approach

- Focus on several scenarios that we will **jointly define with the mining company**.
- **Solve the problem end-to-end**: receiving the events and the Unstructured data from different sensor systems and existing repository, exploration via visualization and predictive models, predictive and proactive event management, optimized decision making, perform actions in a central system and on equipment, and real time monitoring.
- **Using visualization** as a way to bridge the gap between the mining company experts in running a mining operations and the current state of the art that requires statistical and IT knowledge and knowhow.
- **Proactive event driven computing** – an innovative approach that aims at getting decisions and actions a head of time. Critical for safety and mining operations.
- Using open data from governments and scientific sources in our solution enables us to uniquely **leverage information from external sources** that is critical for making the right decisions.
- **The accident model and simulator**: based on statistical analysis and probabilistic modeling of existing physical sensor data from available accident report archives. Will include current state detection and prediction, and provide means for accident simulation, establishing optimal procedures and actions, personnel training, etc.
- **Audio and video processing**: Will add a significant amount of unstructured data to the analysis process.



## Roadmap

- Phase 0 – Understanding and documenting: Requirements, Terminology, Methodologies and processes and flows.
- Phase 1 -
  - 1A) Detailed Scope definition
  - 1B) First version of an **end-to-end solution** on a specific defined scenario demonstrated and piloted at the mining company. The solution should include all the **current** components described in the high-level solution.
- Phase 2 – Second version of the solution. The solution should include:
  - **additional components and advanced capabilities**
  - second pilot on a second scenario
  - incorporating feedback from the first pilot deployment
- Phase 3 – Complete supported **Research asset/solution to be used**
  - More scenarios
  - the mining company-oriented User Interface
  - Pathway and plan defined for potential **wide scale deployment**

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Thank you !

