KRATOS
INTEGRAL SYSTEMS EUROPE

Big Data for Satellite Business Intelligence

GSAW 2015

Loic COULET, Kratos ISE

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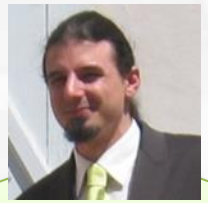
Who's talking?



Loic COULET
Software Engineer

- Passionate
  - Computer Science
  - Learning
- Kratos ISE
  - 10 years
- Now Learning
  - Big Data
  - Analytics
  - NoSQL
- Systems Intregration
  - M&C
  - CSM
  - Satellite C2
- Presenting today
  - Big Data
  - Business Intelligence
- Software
  - Java
  - Databases
  - Web

lcoulet@integ.com

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Kratos Integral Systems Europe (KISE)

Subsidiary of Kratos / Kratos ISI, Toulouse, France

KRATOS®
INTEGRAL SYSTEMS EUROPE

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KISE provides Ground stations solutions

Complete Ground Systems Solutions

One-Stop Shop

KRATOS®
INTEGRAL SYSTEMS EUROPE

Why am I talking today?

SBI Press Release caught attention…

September 11, 2014

Kratos Brings Big Data Analysis to Satellite Operations for Es'hailSat

New Satellite Business Intelligence (SBI) Dashboard Correlates Data Across Key Ground Segment Solutions to Enhance Service Level Management

SAN DIEGO, Sept. 11, 2014 (GLOBE NEWSWIRE) -- Kratos Defense & Security Solutions, Inc. (Nasdaq:KTOS), a leading National Security Solutions provider, announced today that its Kratos Integral Systems Europe (Kratos ISE) subsidiary has delivered a powerful new Satellite Business Intelligence (SBI) dashboard to Es'hailSat, the Qatar satellite company. The SBI dashboard will enable the operator to leverage advanced Big Data technology to better manage service levels and optimize satellite operations.

http://ir.kratosdefense.com/releasedetail.cfm?releaseid=870415

Es'hailSat سهيل سات
Qatar Satellite Company الشركة القطرية للأقمار الصناعية

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Es'hailsat – The Qatar Satellite Company

Es'hailSat سهيل سات
Qatar Satellite Company الشركة القطرية للأقمار الصناعية

The Qatar Satellite Company

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… Using smart keywords…

…For which…

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1 How Big?

3 What kind?

…I have ~~20~~ 15 minutes to speak about

5 What kind of correlation?

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2 What does SBI mean?

4 How is it presented?

6 How does it work?

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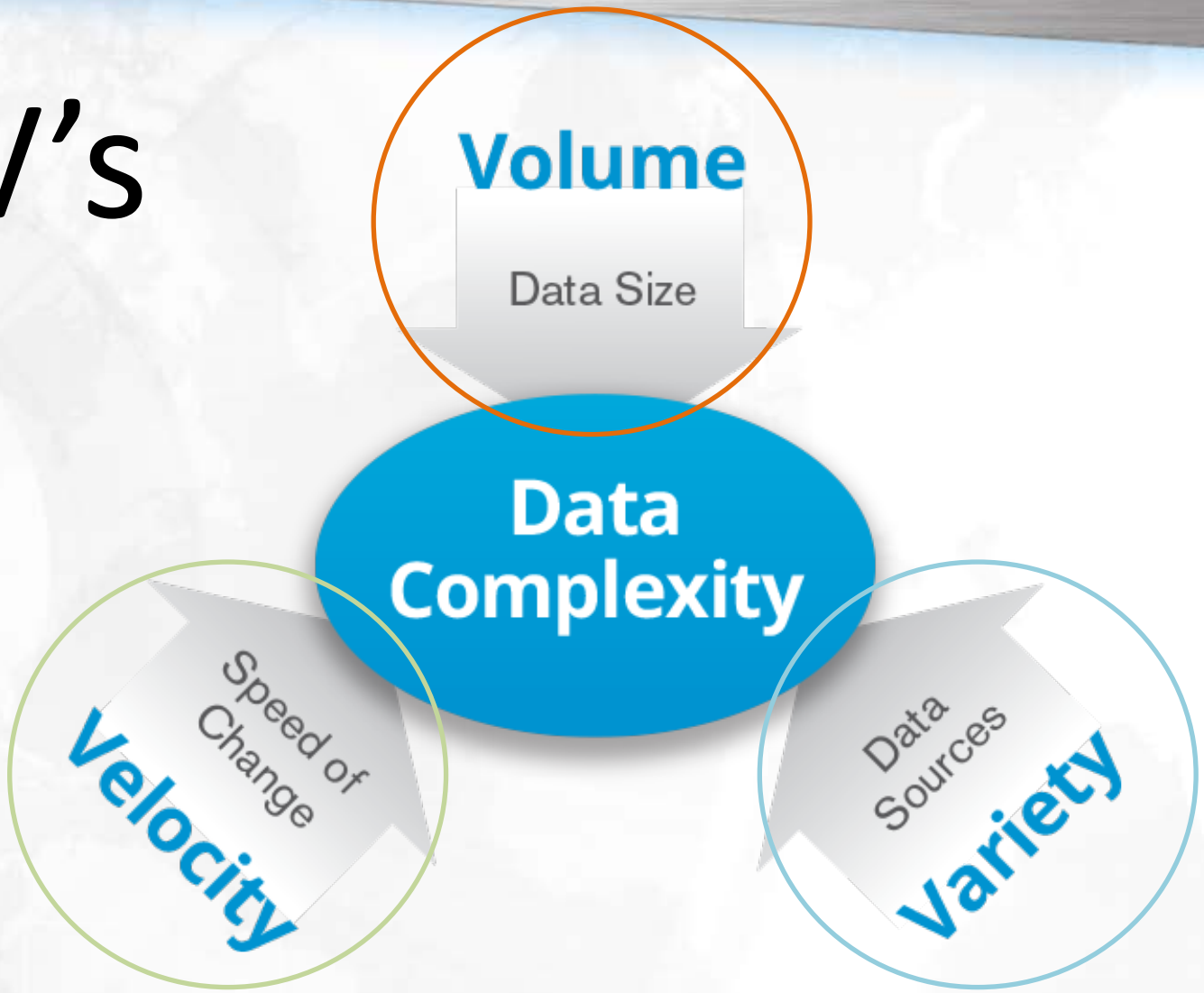
How big is Big?

Big Data = 3V's

3 V's



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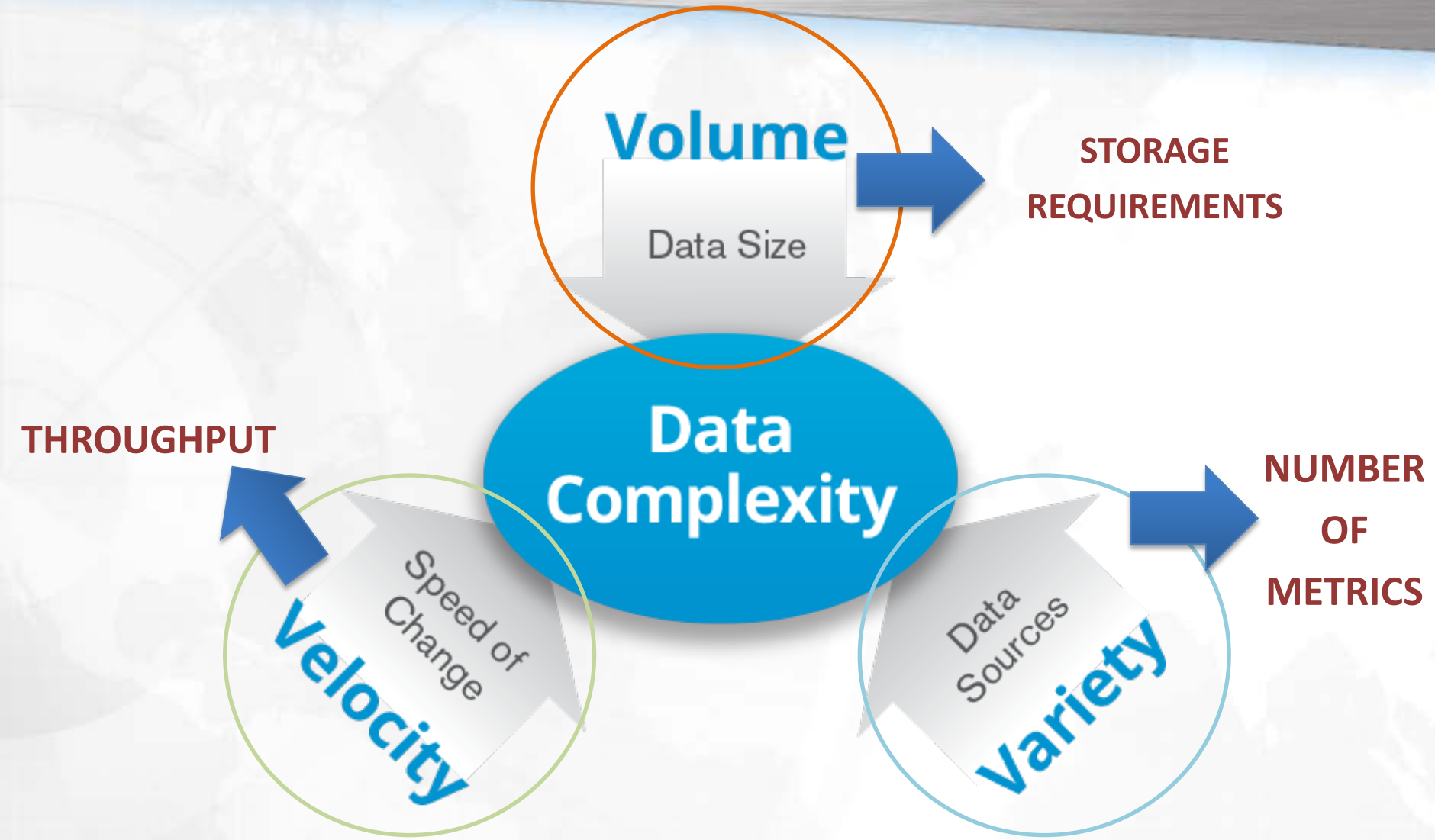
Big Data = 3V's



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Data Source Systems

Monics
CSM

Compass
M&C

Epoch IPS
Satellite C2

Neuralstar
Network Mgmt

OUR FLAGSHIP PRODUCTS

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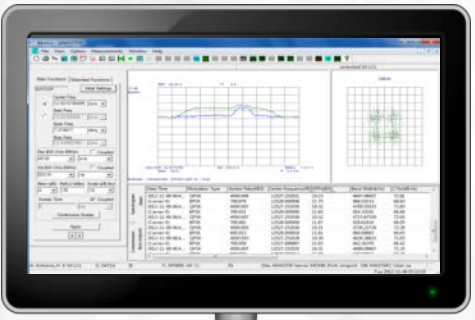
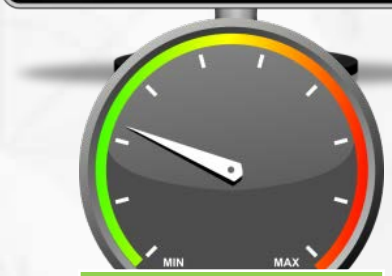
Number of metrics

Monics
CSM





Low

Compass
M&C

High

Epoch
Satellite C2

High

Neuralstar
Network Mgmt

High

NUMBER OF METRICS

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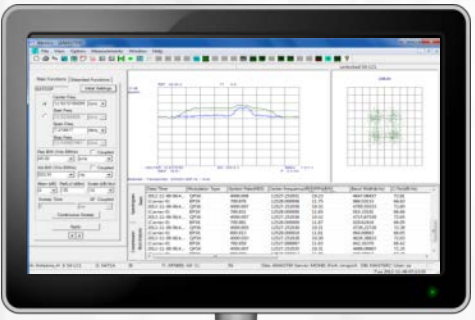
Data Troughput

Monics
CSM



High

Compass
M&C

Low

Epoch
Satellite C2

High

Neuralstar
Network Mgmt

High

THROUGHPUT

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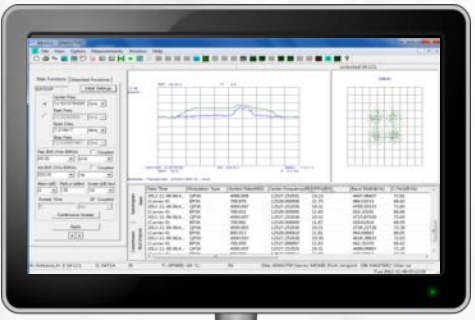
Storage requirements

Monics
CSM



High

Compass
M&C

Medium

Epoch
Satellite C2

High

Neuralstar
Network Mgmt

High

STORAGE REQUIREMENTS

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Big Data problem?

Systems generate…

Large data amount

Real-Time processing

Legacy Storage is everything archived?

AND THEN …

- **Store all data** for any **length of time** ?
- **Correlation** between data sources?
- **Further analysis** to detect unknown information?
- **Learning model** to anticipate failures?

How efficiently is data stored and used?

How Big?

What kind?

What kind of correlation?

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What does SBI mean?

How is it presented?

How does it work?

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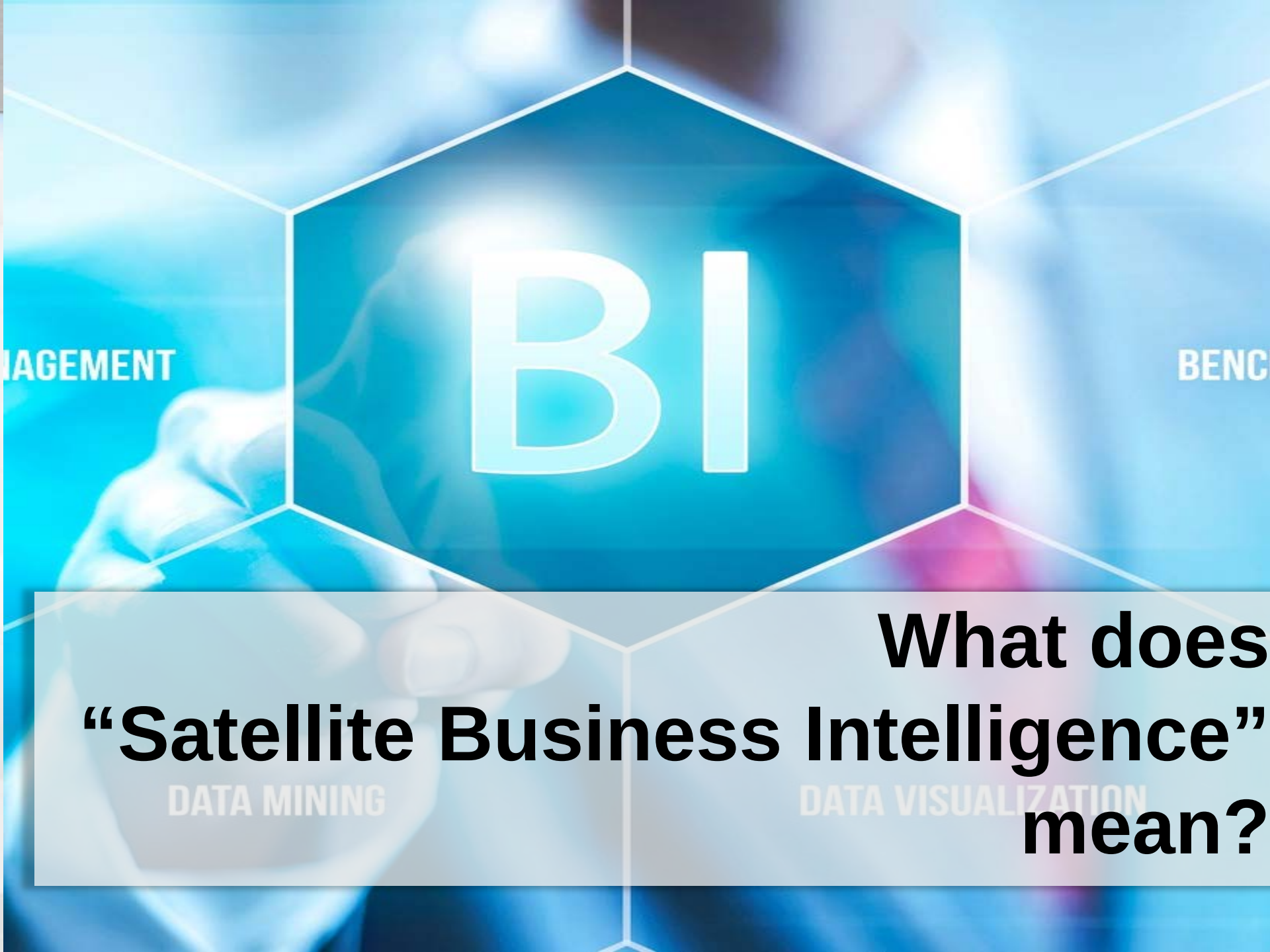

What does “Satellite Business Intelligence” mean?

Satellite Business Intelligence = ?

Business…

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Satellite Business Intelligence = ?

+ Intelligence…

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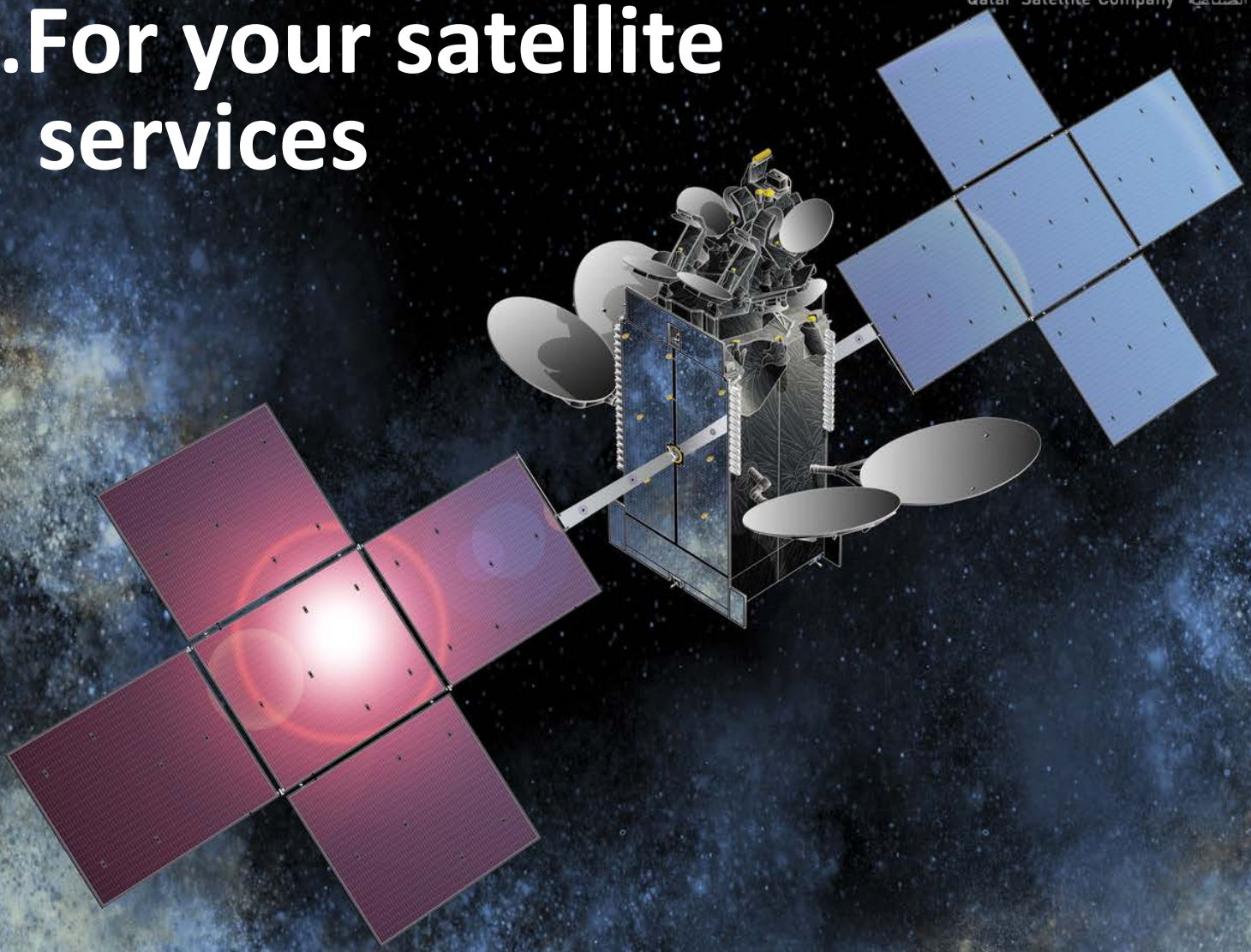
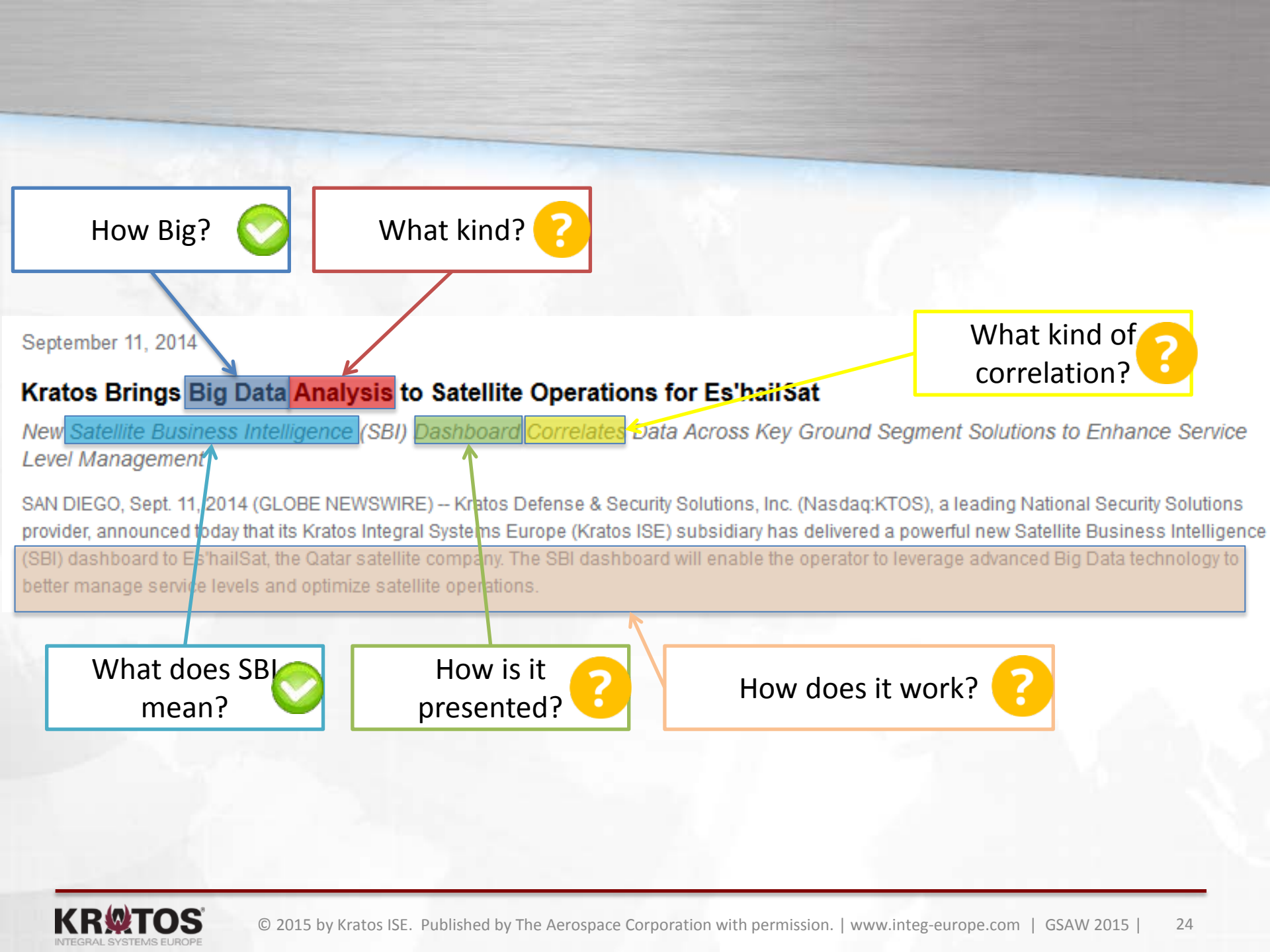
KPI?

Es'hailSat سهيل سات
Qatar Satellite Company الشركة القطرية للأقمار الصناعية

...For your satellite services





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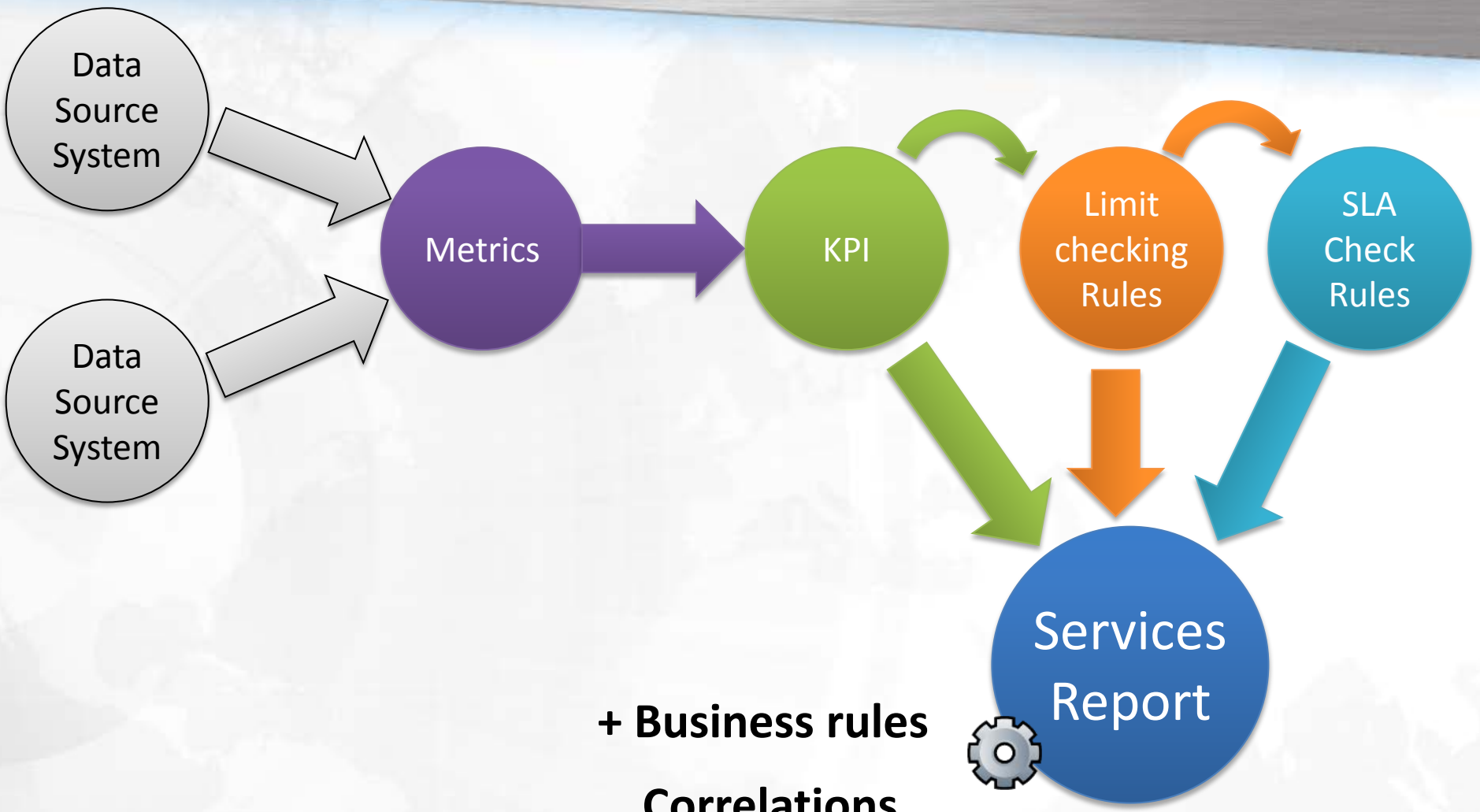
What kind of analysis?

Correlations for services monitoring dashboard



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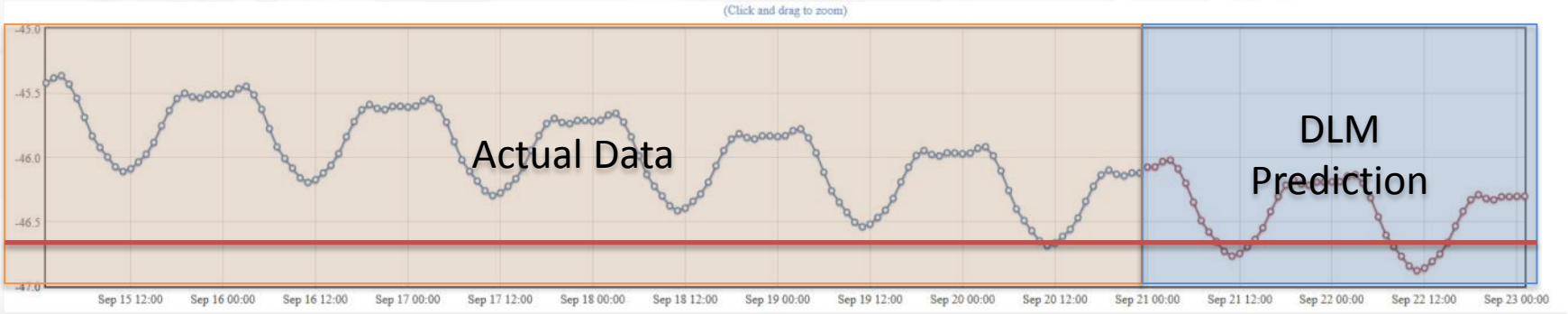
Time Series Prediction analysis

1. Generic predictive analysis (in the query engine) is being implemented



2. Several predictors : linear (exponential Smoothing, holt, least squares), or dymanic with **Dynamic Linear Model (DLM)**

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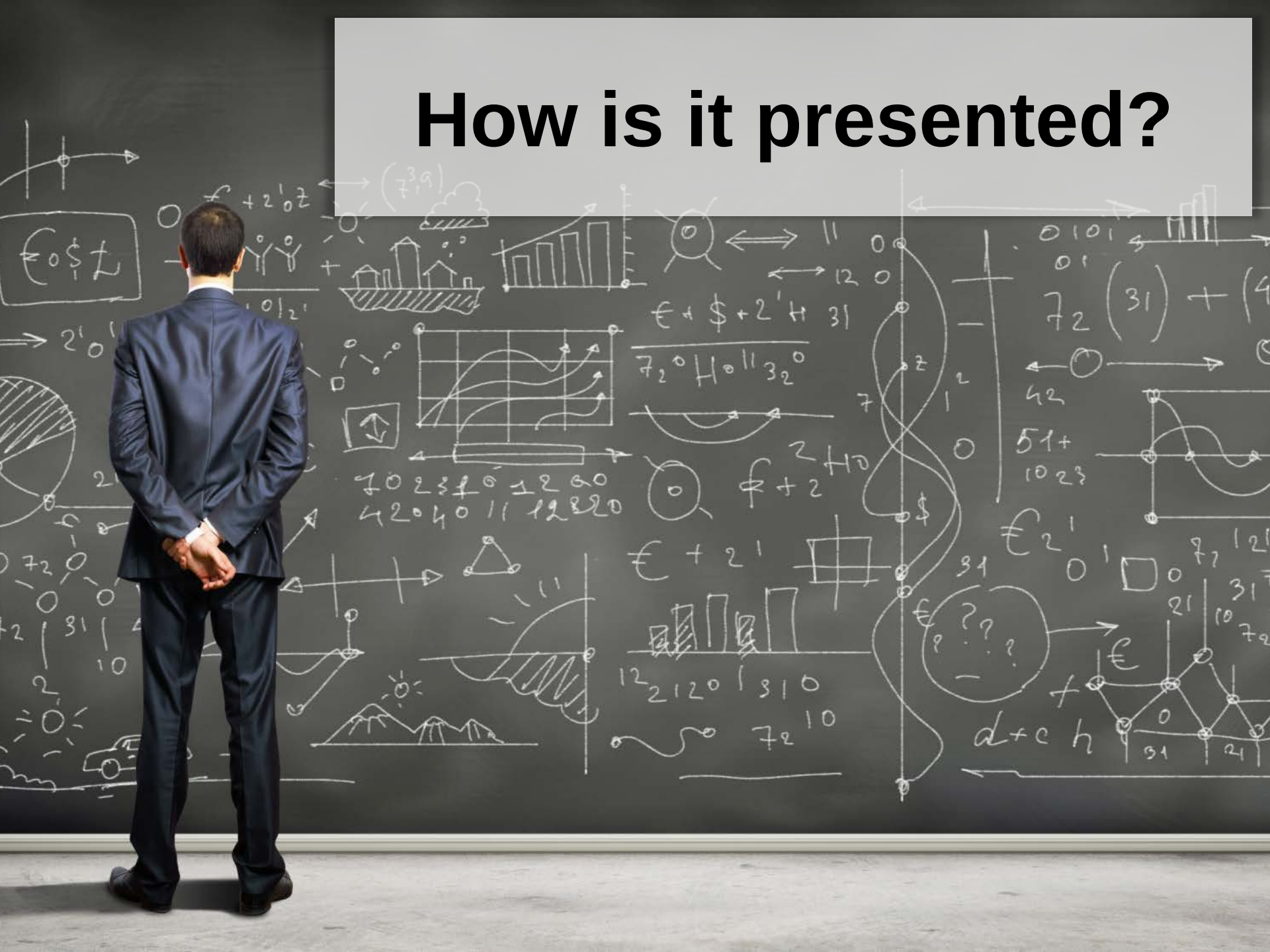
How is it presented?



How is it presented?

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A Dashboard

Grafana Time Series Dashboard

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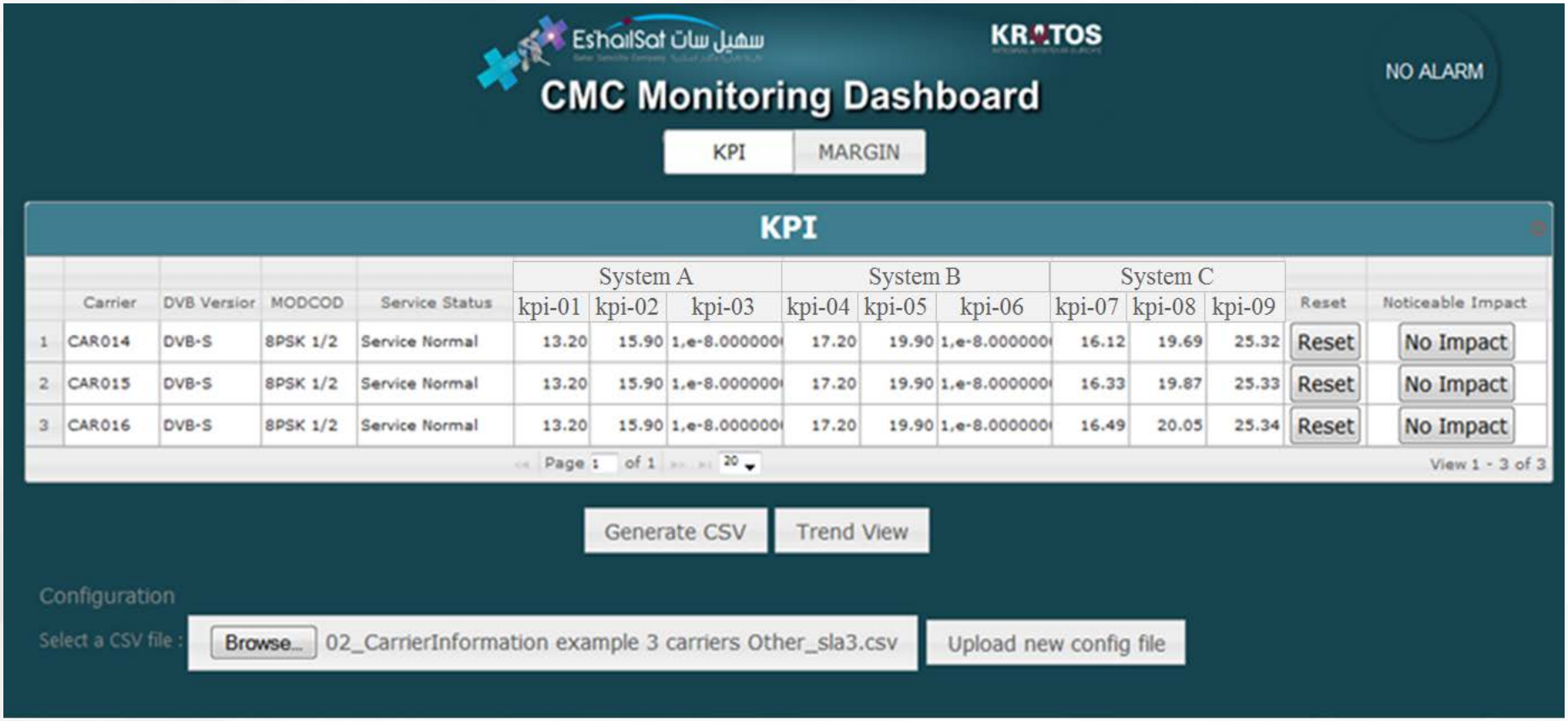
THE Dashboard

Es'hailsat Monitoring Dashboard displays on a Web Browser with real-time information



	Carrier	DVB Version	MODCOD	Service Status	System A kpi-01	System A kpi-02	System A kpi-03	System B kpi-04	System B kpi-05	System B kpi-06	System C kpi-07	System C kpi-08	System C kpi-09	Reset	Noticeable Impact
1	CAR014	DVB-S	8PSK 1/2	Service Normal	13.20	15.90	1,e-8.000000(	17.20	19.90	1,e-8.000000(	16.12	19.69	25.32	Reset	No Impact
2	CAR015	DVB-S	8PSK 1/2	Service Normal	13.20	15.90	1,e-8.000000(	17.20	19.90	1,e-8.000000(	16.33	19.87	25.33	Reset	No Impact
3	CAR016	DVB-S	8PSK 1/2	Service Normal	13.20	15.90	1,e-8.000000(	17.20	19.90	1,e-8.000000(	16.49	20.05	25.34	Reset	No Impact

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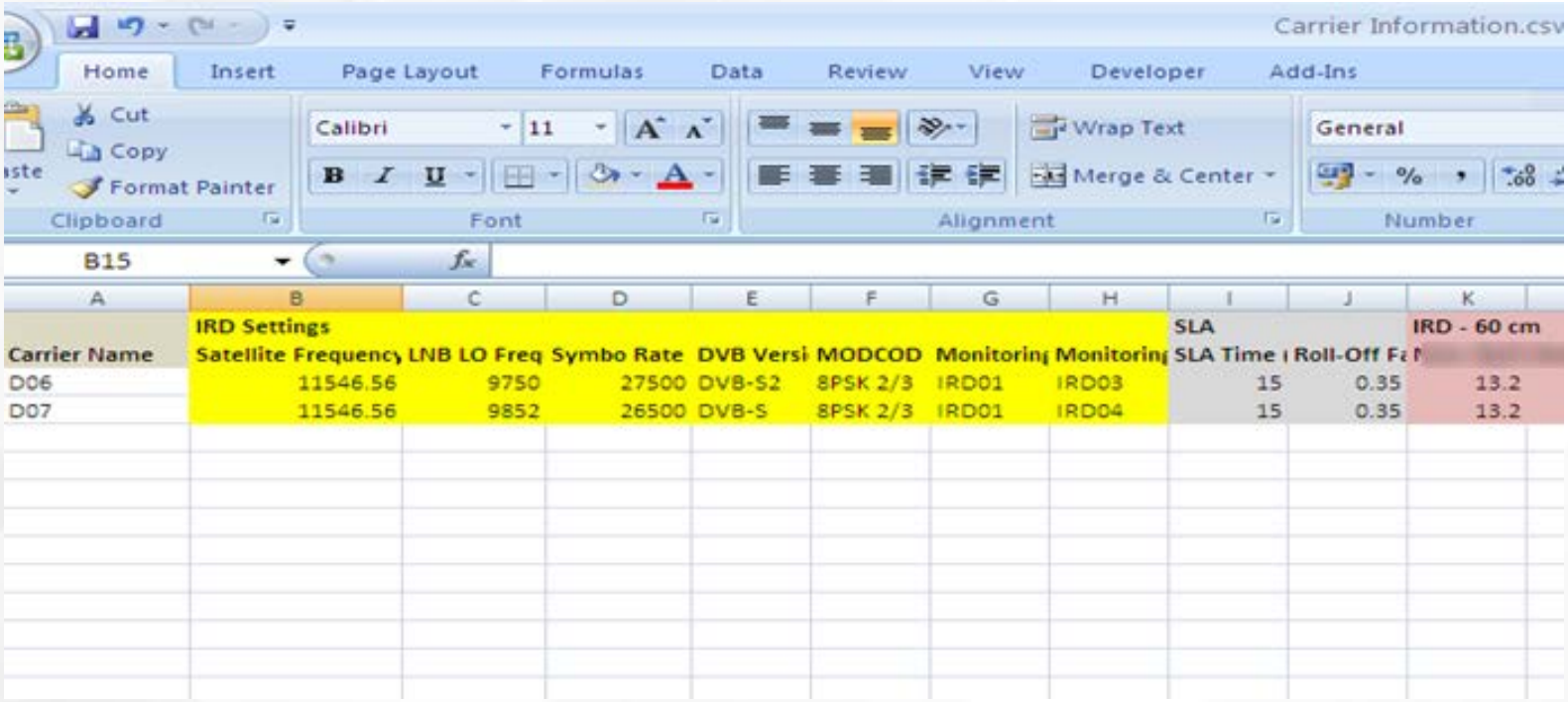
Configuration using a CSV file

The **CMC Monitoring Dashboard** configuration file (**CSV file**) is edited manually by the CMC operator.

Configures:

- KPI Thresholds
- Monitoring Plans
- Monitored Services



	A	B	C	D	E	F	G	H	I	J	K
		IRD Settings							SLA		IRD - 60 cm
1	Carrier Name	Satellite Frequency	LNB LO Freq	Symbo Rate	DVB Versi	MODCOD	Monitoring	Monitoring	SLA Time	Roll-Off Fa	
2	D06	11546.56	9750	27500	DVB-S2	8PSK 2/3	IRD01	IRD03	15	0.35	13.2
3	D07	11546.56	9852	26500	DVB-S	8PSK 2/3	IRD01	IRD04	15	0.35	13.2

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CMC Monitoring Dashboard (Views)

The CMC Monitoring Dashboard User can see 2 different tables (one with the **KPIs** and one with the **MARGINS**)

KPI	MARGIN

Click on the "**KPI**" button to view the latest **Keys Performance Indicators**

KPI

	Carrier	DVB Version	MODCOD	Service Status	Time since last status change	IRD - 60 cm			IRD - 3.8 m			Monics			Reset	Noticeable Impact
1	test	dvb	QPSK-3/4	Service Normal	01-Oct-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
2	test2	dvb2	QPSK-3/4	Service Normal	02-Oct-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	Failure
3	test3	dvb3	8PSK-3/4	Service Normal	01-Sep-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
4	test4	dvb4	QPSK-3/4	Service Normal	04-Oct-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
5	test5	dvb5	QPSK-3/4	Service Normal	31-Oct-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
6	test6	dvb6	QPSK-3/4	Service Interruption	06-Sep-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
7	test7	dvb7	QPSK-3/4	Service Normal	04-Oct-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
8	test8	dvb8	8PSK-3/4	Service Normal	03-Oct-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
9	test9	dvb9	QPSK-3/4	Service Normal	01-Sep-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
10	test10	dvb10	QPSK-3/4	Service Degradation	08-Sep-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
11	test11	dvb11	QPSK-3/4	Service Normal	08-Sep-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact
12	test12	dvb12	QPSK-3/4	Service Failure	10-Sep-2007 00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Reset	No Impact

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System A System B System C

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CMC Monitoring Dashboard (Margin View)

Click on the "**MARGIN**" button to view the margins

MARGIN

	Carrier	DVB Version	MODCOD	Service Status	Time since last status change	IRD - 60 cm			IRD - 3.8 m			Monics			Reset	Noticeable Impact
1	D63	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-42.85	Reset	No Impact
2	D62	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-15.86	Reset	No Impact
3	D65	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	6.66	Reset	No Impact
4	D64	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-25.22	Reset	No Impact
5	D67	DVB-S	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	3.03	Reset	No Impact
6	D66	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	6.42	Reset	No Impact
7	D69	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-40.00	Reset	No Impact
8	D68	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-45.44	Reset	No Impact
9	D70	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-35.48	Reset	No Impact
10	D72	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-14.77	Reset	No Impact
11	D71	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	6.27	Reset	No Impact
12	D74	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-42.94	Reset	No Impact
13	D73	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	6.56	Reset	No Impact
14	D76	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-38.24	Reset	No Impact
15	D75	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-29.46	Reset	No Impact
16	D78	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-9.87	Reset	No Impact
17	D77	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	9.80	Reset	No Impact
18	D79	DVB-S2	8PSK 2/3	Service Normal	2014/06/10 16:40	3.00	3.00	1,000.00	3.00	3.00	1,000.00	3.00	3.00	-39.99	Reset	No Impact

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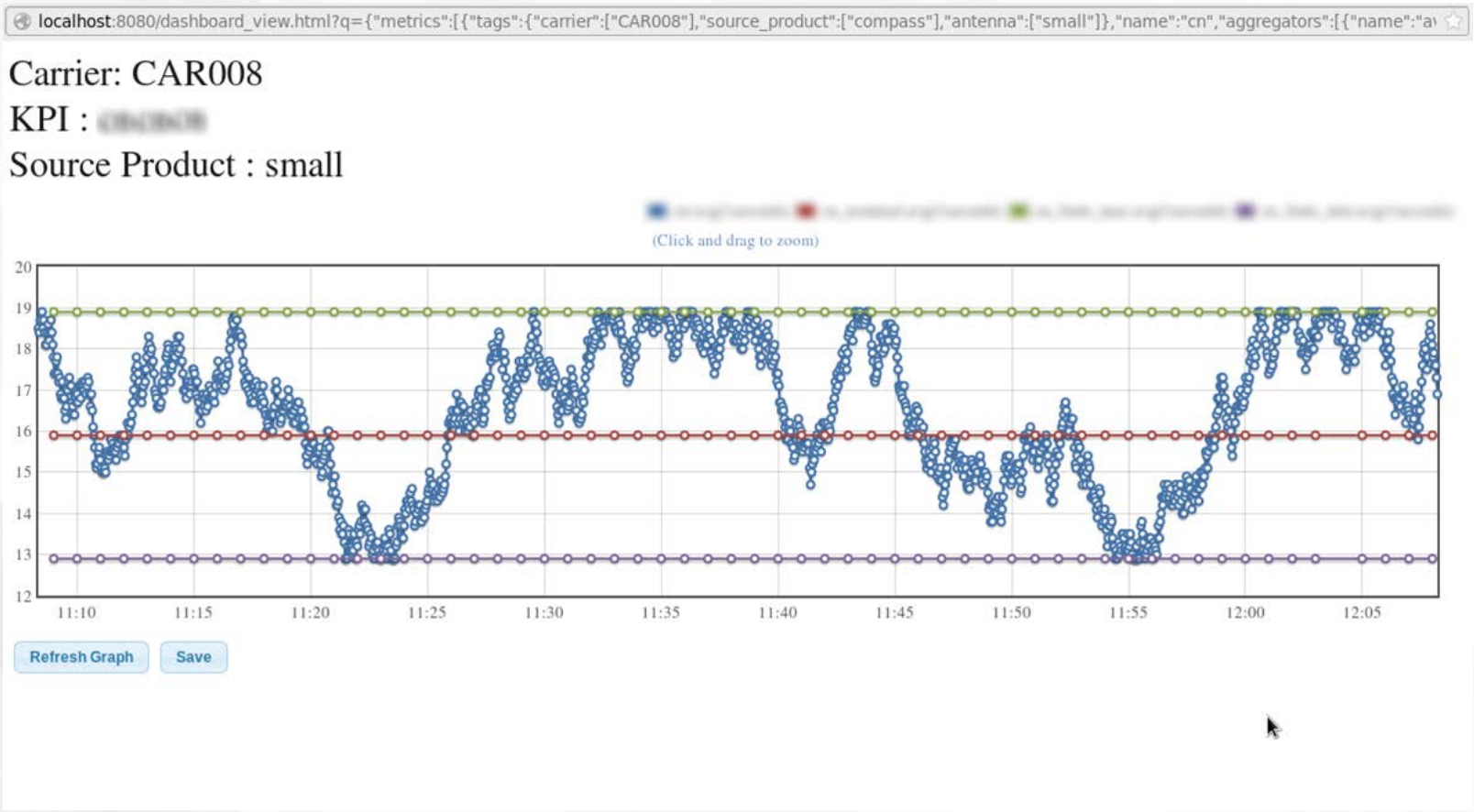
CMC Monitoring Dashboard (KPI view – Plots)

Double Click on a KPI to see the real time plot



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CMC Monitoring Dashboard (KPI view – Trend)

Click on the **Trend View** Button to view the historical values of the KPIs

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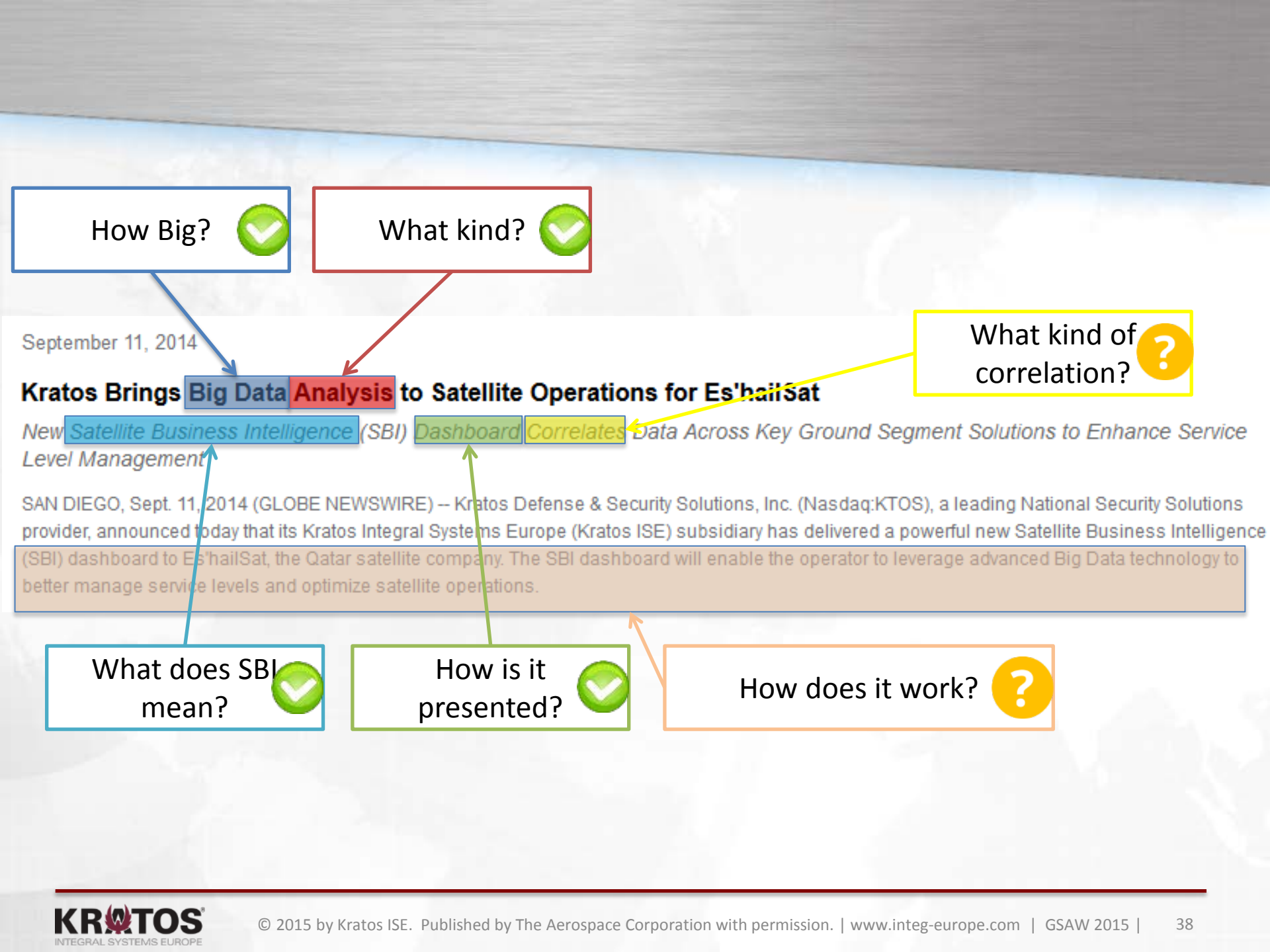

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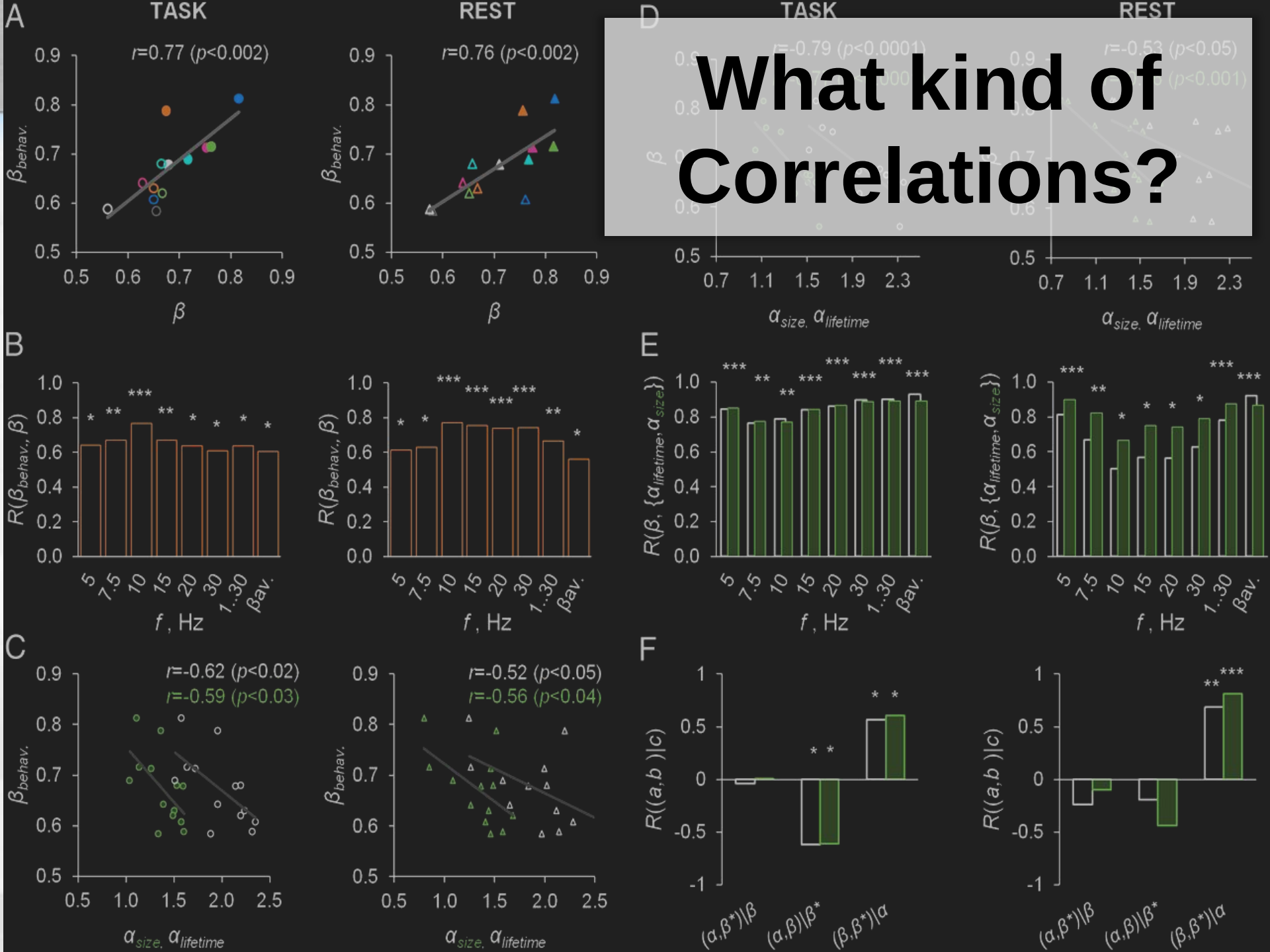
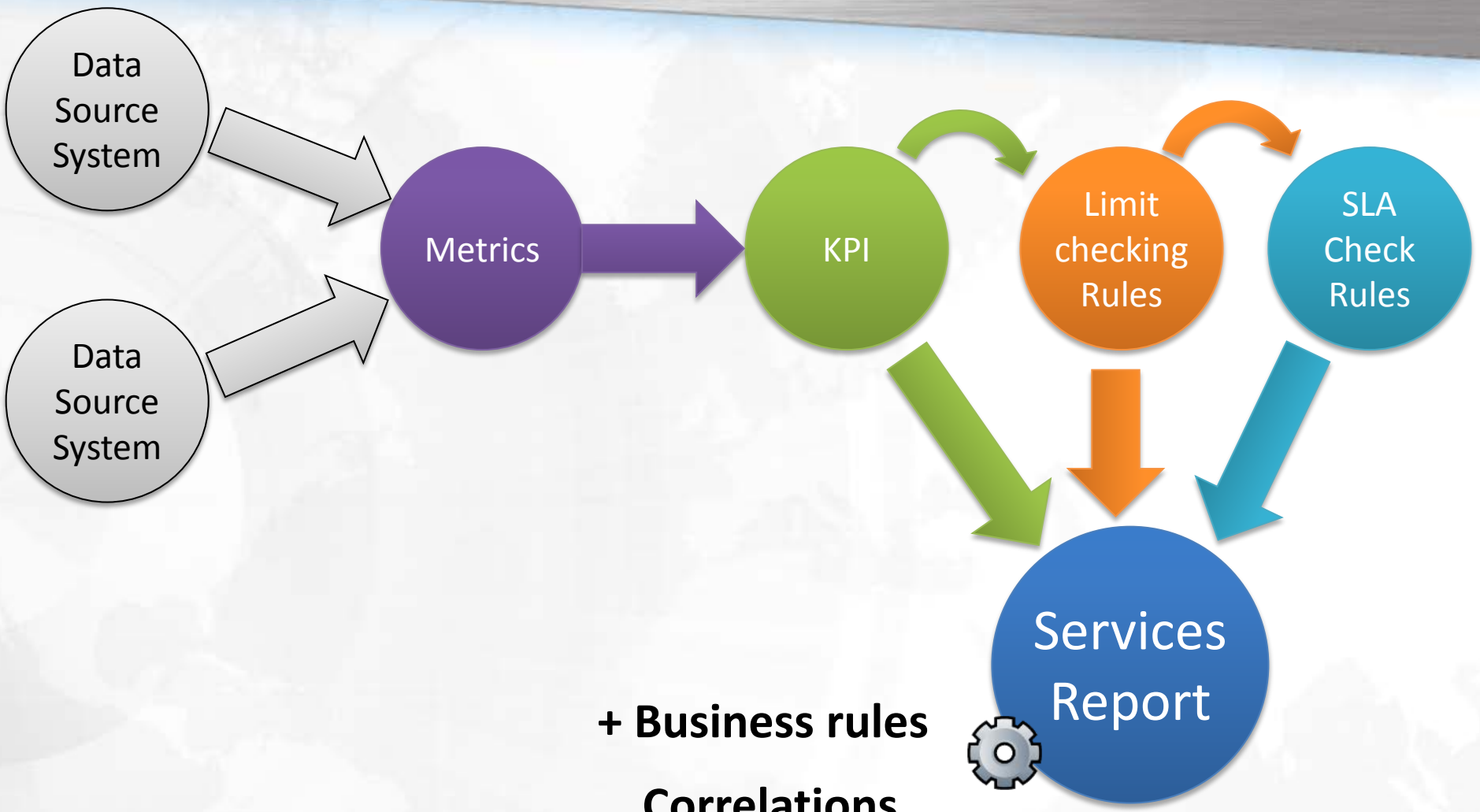


What kind of Correlations?

Correlations for services monitoring dashboard



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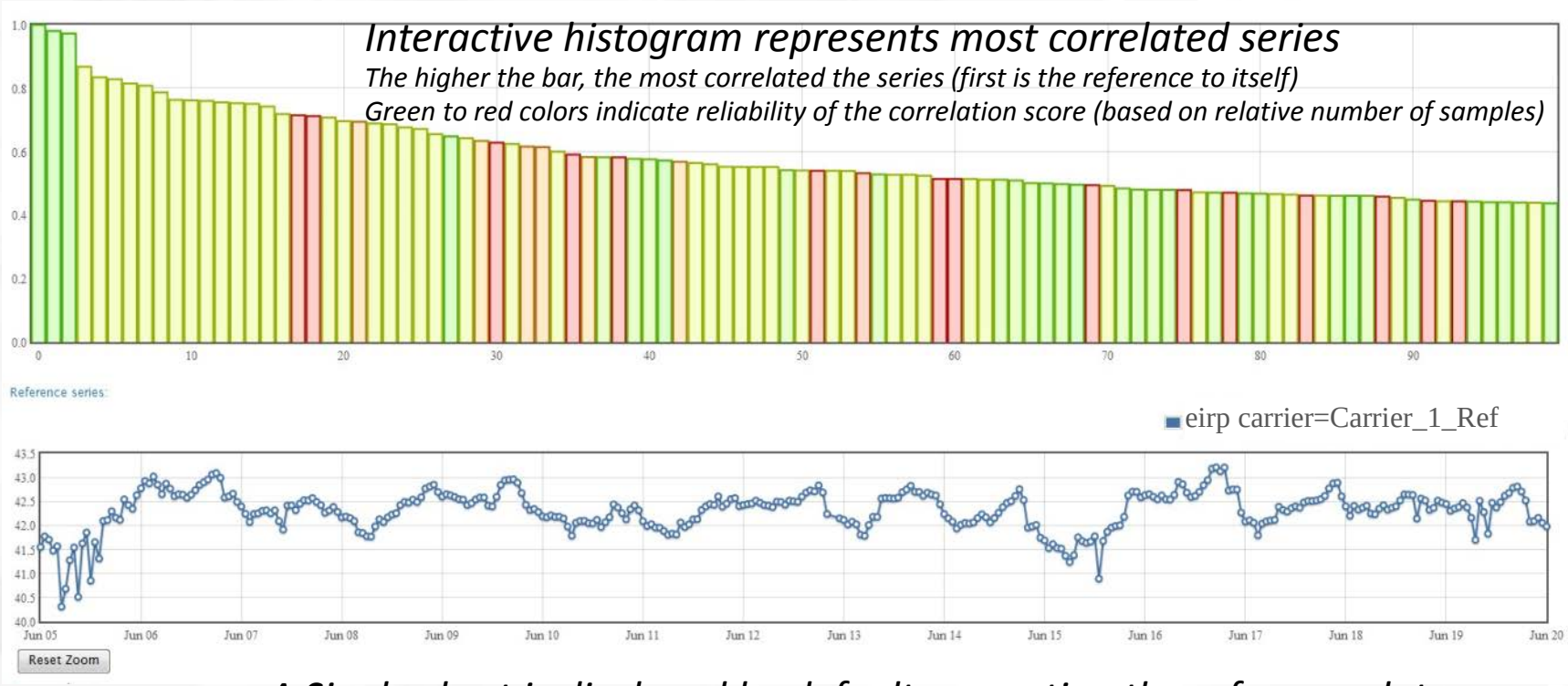
Search correlations

Correlate one reference series to many others



A Single chart is displayed by default presenting the reference data

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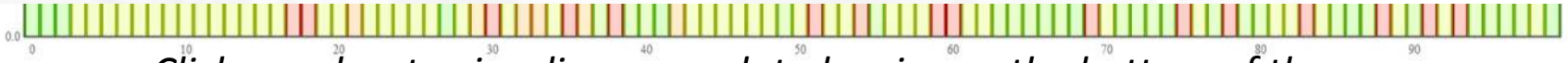
Time Series Correlations Analysis - Search

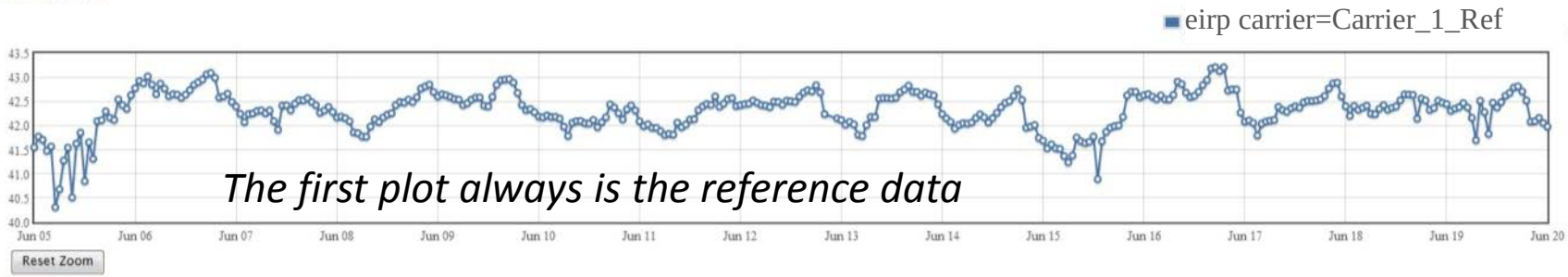
Visualizing Correlation results

This shows real data samples…



Click on a bar to visualize a correlated series on the bottom of the page.

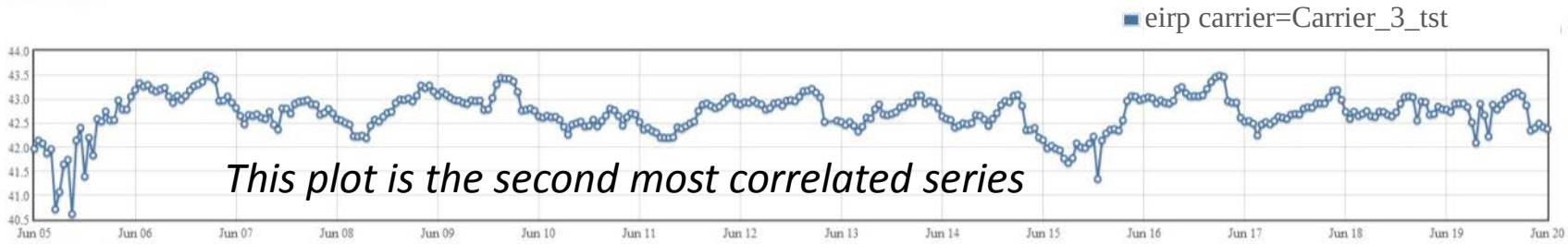
Reference series:



The first plot always is the reference data

Reset Zoom

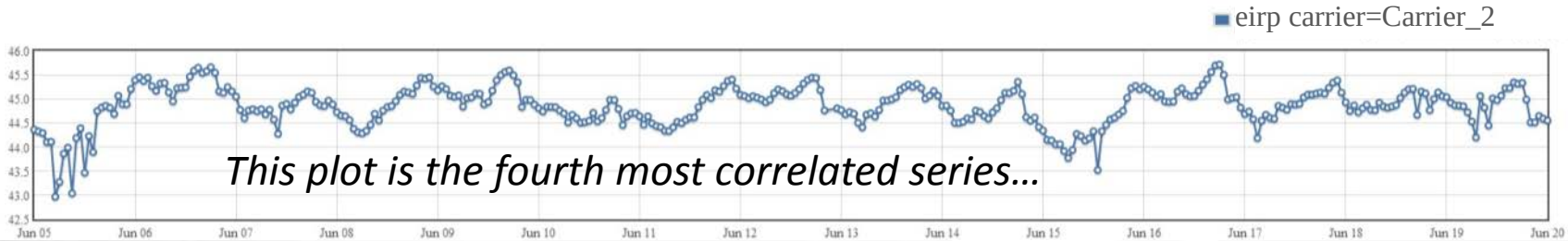
Compared series:



This plot is the second most correlated series

Reset Zoom

Delete (info)



This plot is the fourth most correlated series…

Time Series Correlations Analysis - Discover

Same query model than in correlations search

Interactive correlation matrix

Mouse over a square in the matrix provides information about correlated metrics.
Click shows the two plots.

Change reliability threshold

Do clustering using metric tags

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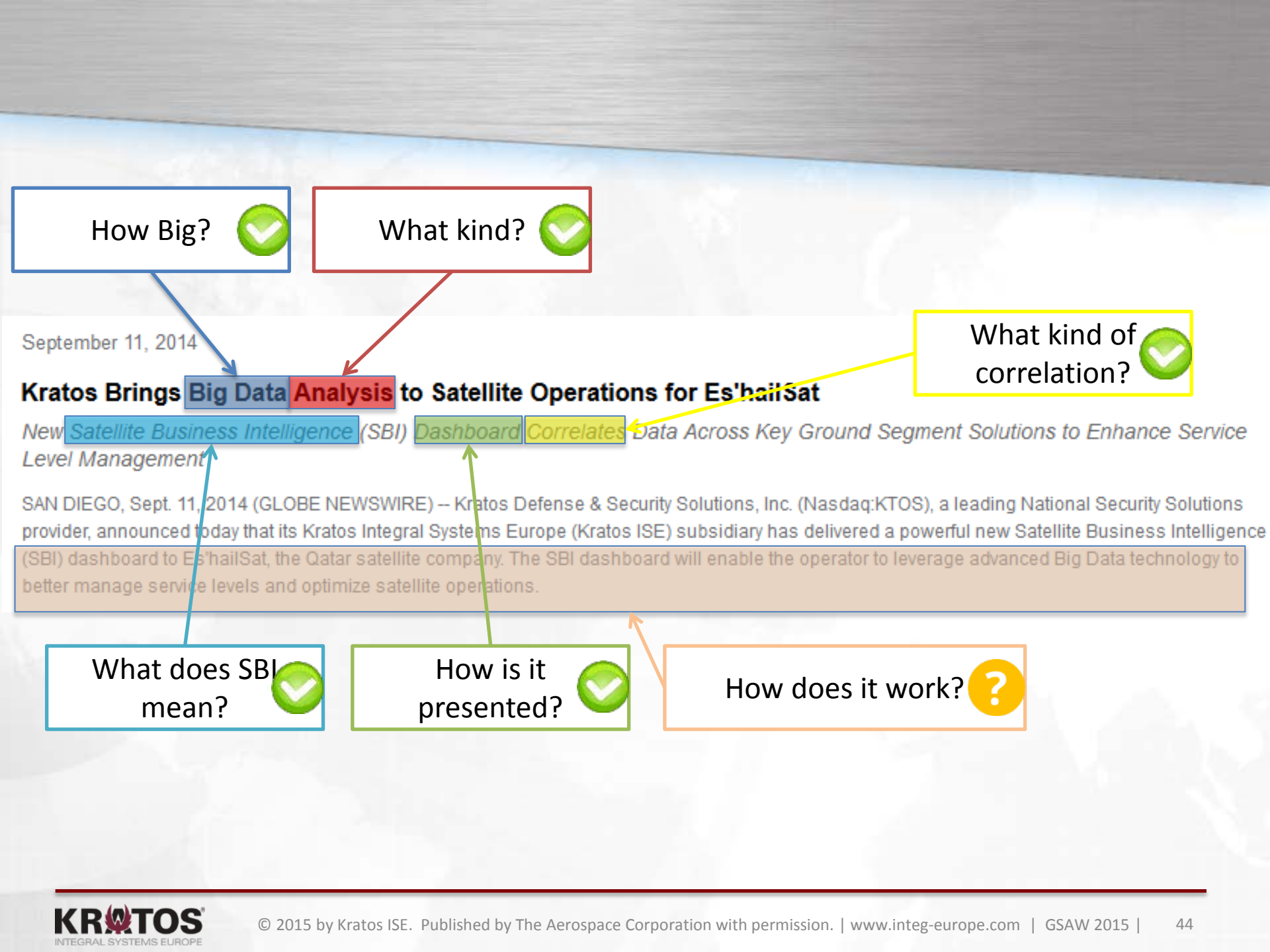

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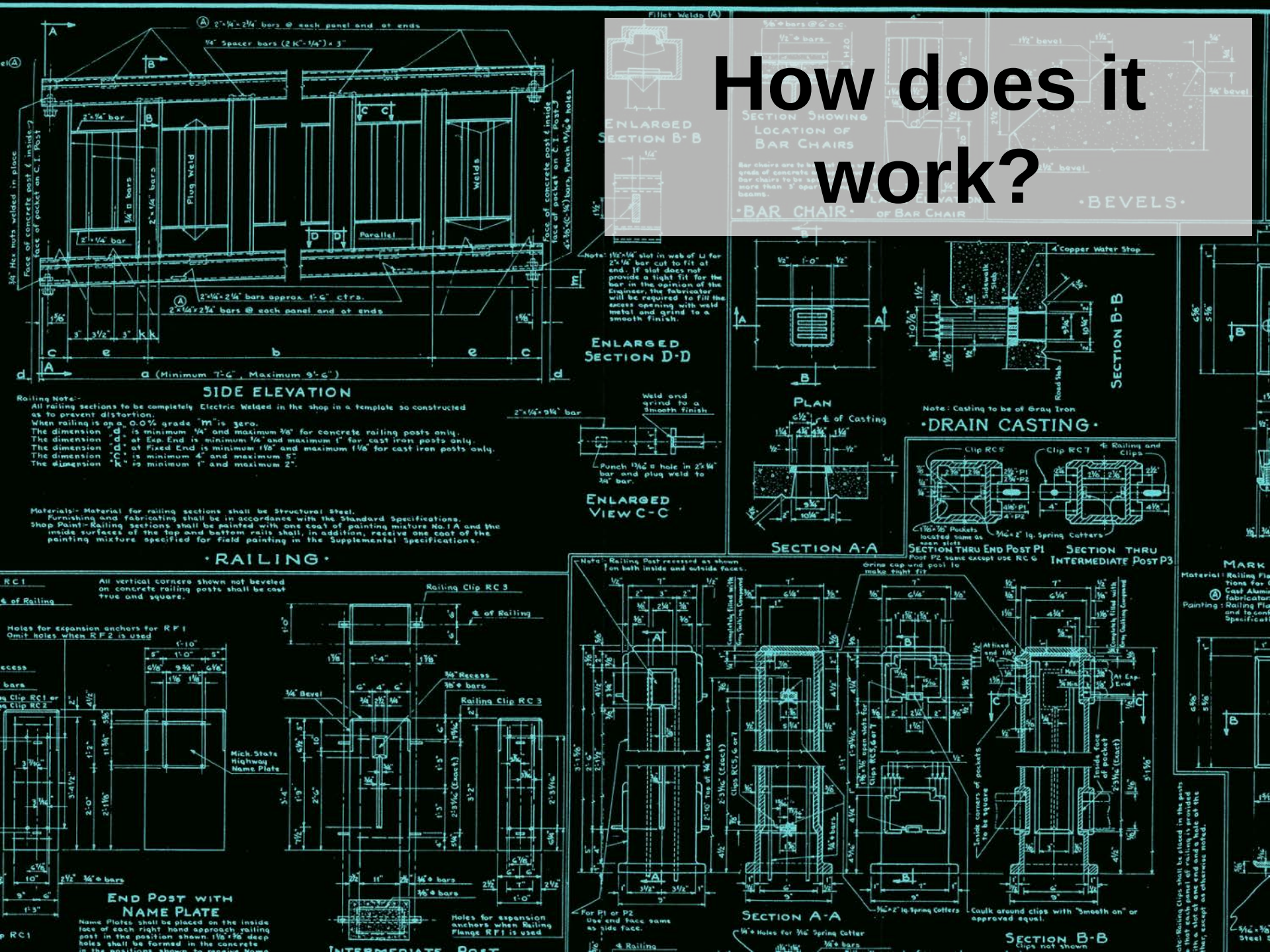
How does it work?
SIDE ELEVATION
·RAILING·
ENLARGED SECTION D-D
ENLARGED VIEW C-C
PLAN
SECTION A-A
SECTION B-B
·DRAIN CASTING·
SECTION THRU END POST P1
SECTION THRU INTERMEDIATE POST P3
END POST WITH NAME PLATE
SECTION A-A
SECTION B-B
·BEVELS·
·BAR CHAIR·

How does it work?

- Time Series Database (KairosDB)
- NoSQL Database as storage backend (Apache Cassandra)
- Domain expertise and integration skills

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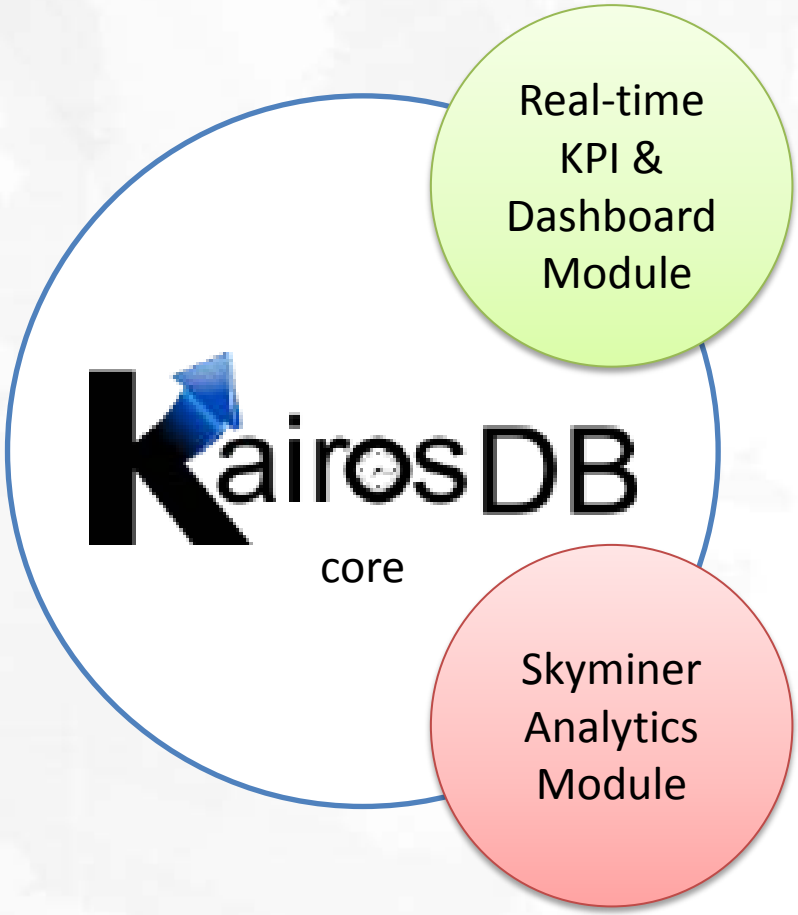
KairosDB is modular



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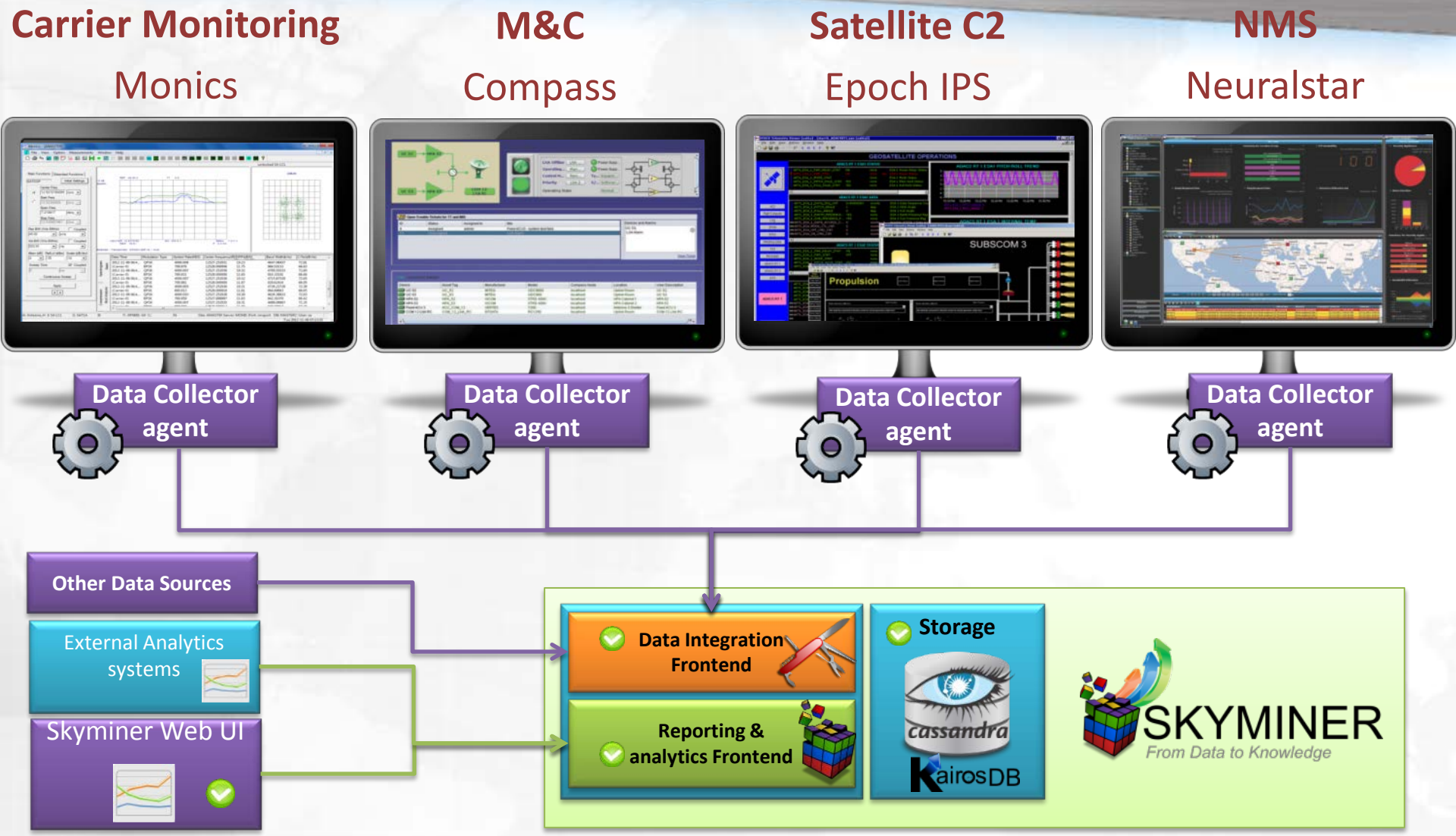
Solution



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Primary Goals

1. Time series monitoring & analytics
2. Fast
3. Flexible & Scalable
4. Fault tolerant
5. Incorporates useful analysis features
6. Open to other systems
7. Cost-controlled

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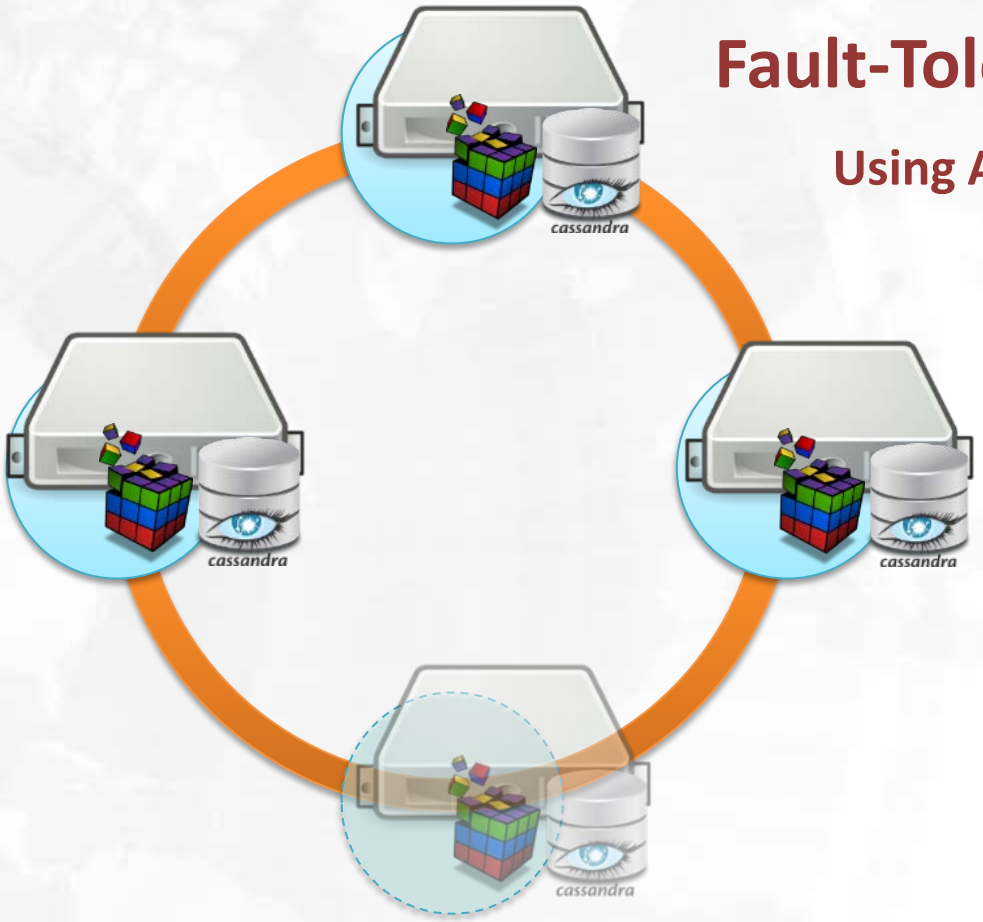
Typical System(s)

Fault-Tolerant Small Cluster

Using Apache Cassandra DB



Low cost Quick start Fault management Data replication

Easy administration Scale to any size Best performances

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Interoperability Features

1. All features are provided as web services (HTTP / REST)
2. Open APIs
3. Interoperable data format based on JSON
4. Intuitive Web UI for starting using the system
5. APIs include:
   - Data acquisition
   - Data querying
   - Analysis features (prediction, correlations)

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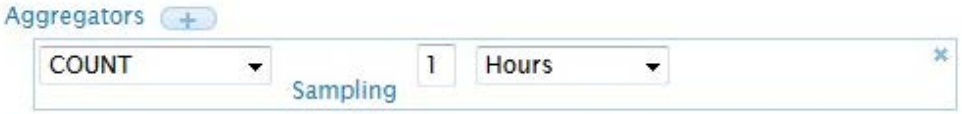
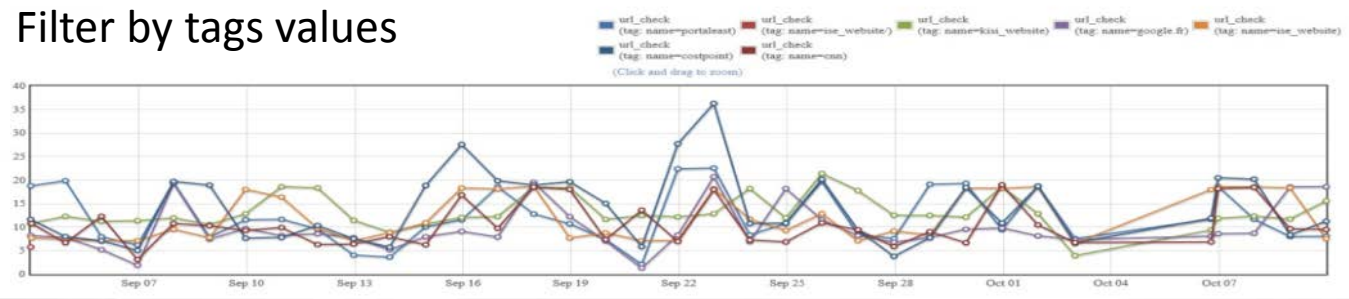
Query Engine & aggregations

- Ad-hoc queries and statistics calculation
- Business Intelligence features already implemented (aggregate, drill & pivot)
  - Data aggregates: Min, Max, Sum, Average, Count, Rate, Std Deviation…etc



  - Multi-level Group-by feature using tags, value, or time

  - Filter by tags values



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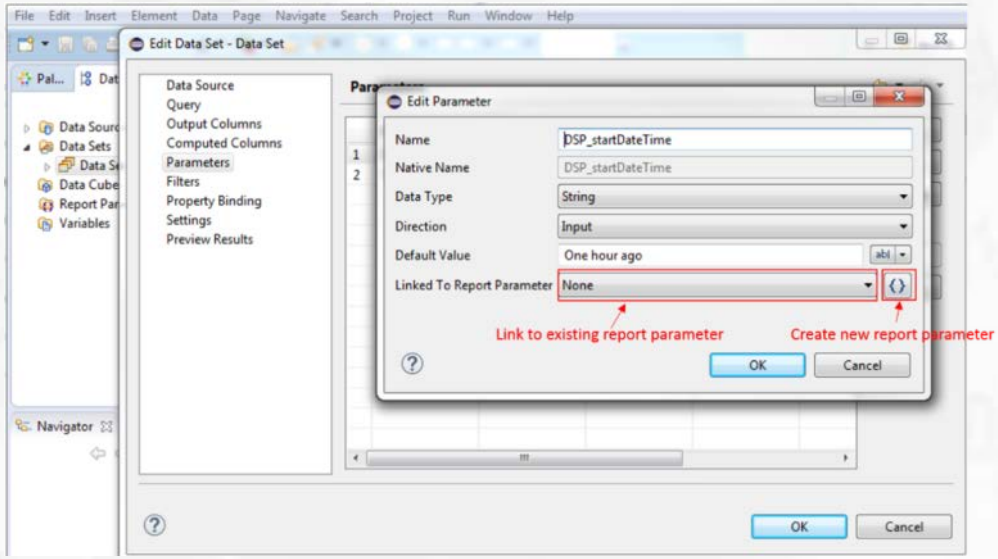
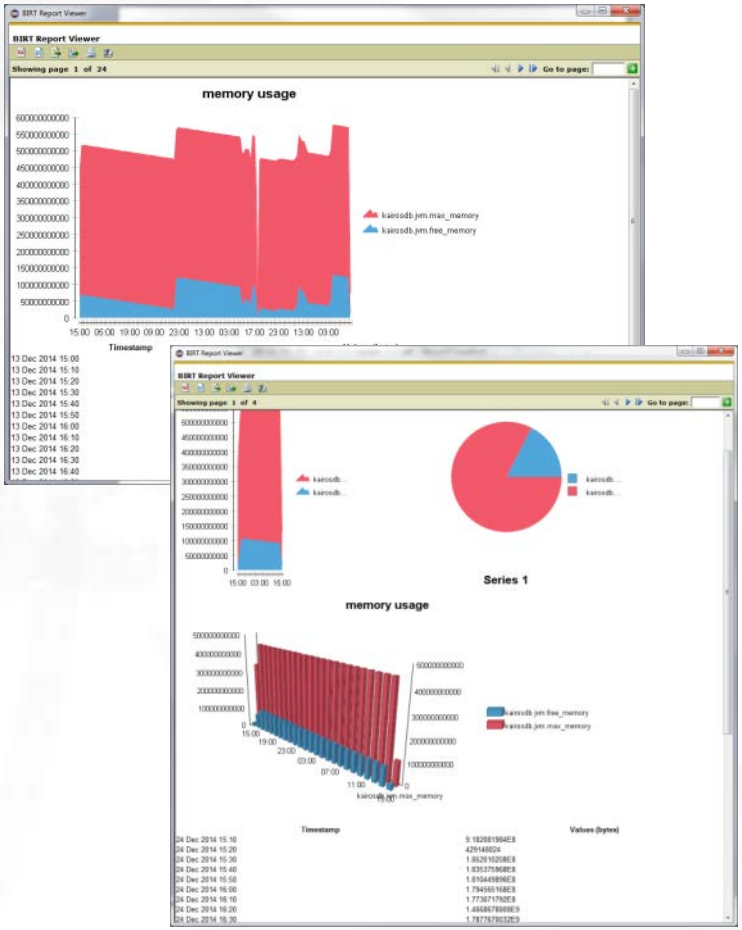
Reporting

Using BIRT reporting tool





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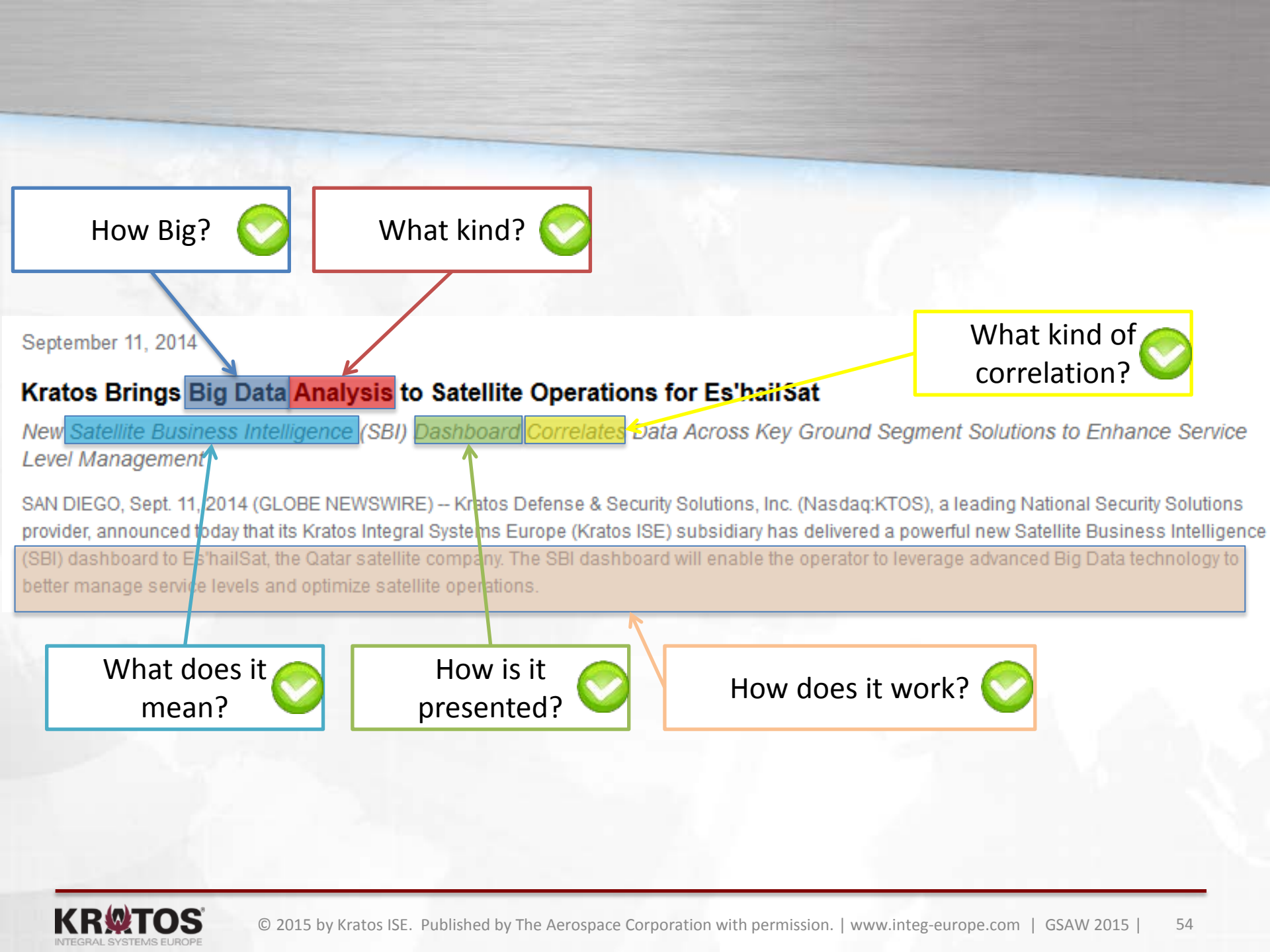

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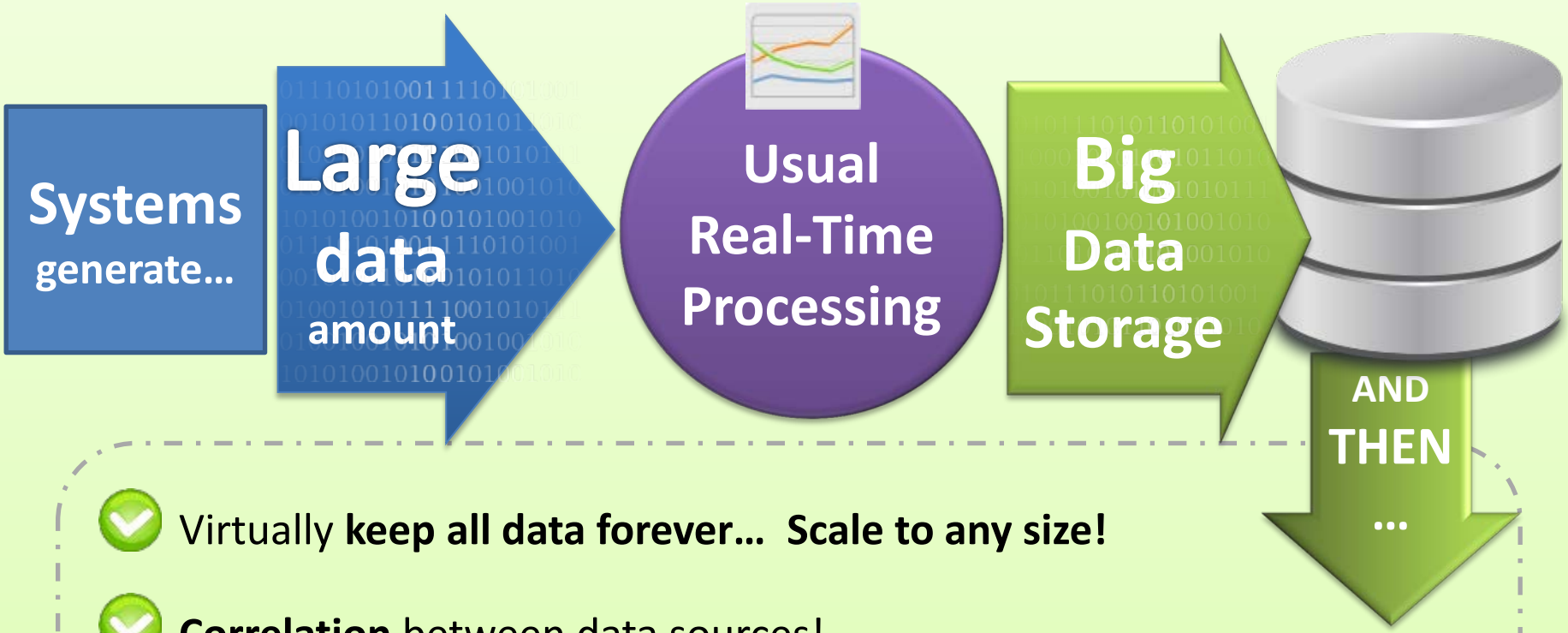
Conclusion



- Virtually **keep all data forever… Scale to any size!**
- **Correlation** between data sources!
- **Automated analysis** for new information?
- **Learning model** to anticipate failures?

SKYMINER
From Data to Knowledge

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Thank You !

lcoulet@integ.com

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Qatar Satellite Company الشركة القطرية للأقمار الصناعية

Any Questions?