ATM Modernization

Digitalization or Digital Transformation?

Presented to: ATIEC 2019

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Date: September 24, 2019

Aviation Information World – Forecasting the Future

Tech is Transforming the World?

Patients dying while waiting for an organ donor could soon be a thing of the past. By 2030, **organs will be biologically 3D-printed on demand.**

Source: World Economic Forum, Healthcare in 2030: goodbye hospital, hello home-spital

Fundamental shift in treatments

Fundamental shift in prevents events

In initial tests, a **machine-learning algorithm created at Carnegie Mellon was able to predict heart attacks** four hours in advance, with 80% accuracy.

Source: The Economist, Of prediction and policy

Usage-based auto insurance enabled by the Internet of Things will grow nearly 1,200% by 2023. This insurance uses real-time information about a driver's actual driving to assess actuarial risk.

Source: IHS Markit, Usage-Based Insurance Expected to Grow to 142 Million Subscribers Globally by 2023, IHS Says

Fundamental shifts In business models

Fundamental shift In privacy concerns

After watching 5,000 hours of TV, **Google's DeepMind AI was able to lip-read 34% more accurately than a professional lip-reader.**

Source: New Scientist, Google's DeepMind AI can lip-read TV shows better than a pro

In 2016, 80% of companies purchased a stand-alone **cyber security insurance** policy, up from 51% in 2015.

Source: RIMS, the risk management society, 2016 RIMS Cyber Survey

Fundamental shift in risk models

"99 Facts on the Future of Business in the Digital Economy", Peter Johnson, SAP Marketing Strategy and Thought Leadership. https://www.slideshare.net/sap/99-facts-on-the-future-of-business-in-the-digital-economy-2017?qid=fcb2ba7c-c6ae-4e44-86e4-9530ed7c2371&v=&b=&from_search=15

What Does That Mean to Aviation?

Joint Planning and Development Office EA OV-1 Graphic - Modified

Headwinds in Aviation Sector

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'Why I'm using a drone to stop Heathrow flights' [1]

By Catrin Nye
Victoria Derbyshire programme

13 September 2019

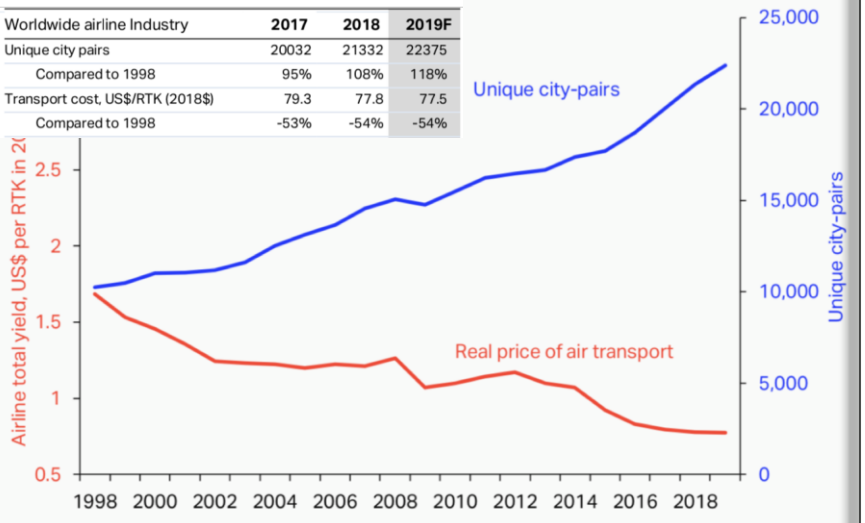
UK climate change protests

Sylvia Dell will be flying a drone during the protests

EU airspace inefficiency	2016	2017	2018
Delay minutes, million	15.6	15.9	25.7
% change over year	10.7%	2.0%	61.8%
Operating cost to airlines, US$m	1,402	1,398	2,159
Passenger time value loss, US$m	1,513	1,583	2,526

City-pair connections and real transport yields [2]

Worldwide airline Industry	2017	2018	2019F
Unique city pairs	20032	21332	22375
Compared to 1998	95%	108%	118%
Transport cost, US$/RTK (2018$)	79.3	77.8	77.5
Compared to 1998	-53%	-54%	-54%



Source: IATA Economics, Economic Performance of the Airline Industry, Mid-year 2019

North America			
Net post-tax profit, $billion	17.8	14.5	15.0
Per passenger, $	18.86	14.66	14.77
% revenue	7.5%	5.7%	5.5%
RPK growth, %	3.9%	5.3%	4.3%
ASK growth, %	3.8%	4.9%	4.1%
Load factor, % ATK	64.9%	64.9%	65.2%
Breakeven load factor, % ATK	57.7%	59.0%	59.5%
Europe			
Net post-tax profit, $billion	8.9	9.4	8.1
Per passenger, $	8.27	8.20	6.75
% revenue	4.7%	4.7%	3.7%
RPK growth, %	9.1%	7.5%	4.9%
ASK growth, %	6.7%	6.6%	5.6%
Load factor, % ATK	74.3%	74.8%	74.0%
Breakeven load factor, % ATK	68.4%	70.2%	70.2%

Note: RPK = Revenue Passenger Kilometers, ASK = Available Seat Kilometers, ATK = Available Tonne Kilometers. **Current year or forward-looking industry financial assessments should not be taken as reflecting the performance of individual airlines, which can differ significantly.** Sources: ICAO, IATA

Worldwide airline Industry	2017	2018	2019F
Fuel spend, $billion	149	180	206
% change over year	10.3%	20.5%	14.3%
% operating costs	21.4%	23.5%	25.0%
Fuel use, billion litres	341	359	368
% change over year	5.9%	5.2%	2.5%
Fuel efficiency, litre fuel/100atk	23.0	22.8	22.4
% change over year	-0.2%	-0.9%	-1.7%
CO_2, million tonnes	860	905	927
% change over year	5.9%	5.2%	2.5%
Fuel price, $/barrel	66.7	86.1	87.5
% change over year	28.0%	29.1%	1.6%
% spread over oil price	21.5%	20.3%	25.0%
Upstream oil profits, $billion	14	16	16

Note: ATK = Available Tonne Kilometers. Sources: Ascend, ICAO, IATA.

Worldwide airline Industry	2017	2018	2019F
Spend on air transport*, $billion	787	845	899
% change over year	6.3%	7.5%	6.3%
% global GDP	0.9%	1.0%	1.0%
Return fare, $/pax. (2018$)	345	327	317
Compared to 1998	-58%	-60%	-61%
Freight rate, $/kg (2018$)	1.76	1.92	1.86
Compared to 1998	-64%	-61%	-62%
Passenger departures, million	4,095	4,378	4,579
% change over year	7.3%	6.9%	4.6%
RPKs, billion	7758	8330	8746
% change over year	8.1%	7.4%	5.0%
FTKs, million	254	262	262
% change over year	9.7%	3.4%	0.0%
World GDP growth, %	3.2%	3.1%	2.7%
World trade growth, %	5.6%	3.9%	2.5%

Note: RPK = Revenue Passenger Km, FTK = Freight & mail Tonne Km
GVA = Gross Valued Added (firm-level GDP). *Airline revenue + indirect taxes.
Sources: IATA, ICAO, OE, CPB, PaxIS, CargoIS

1 -https://www.bbc.com/news/uk-england-london-49636149#
2- International Air Transport Association Development Outlook

ATM Modernization

Digitalization or Digital Transformation?

Going digital, or Digitalization[1]

- ✓ The process of converting something to digital form

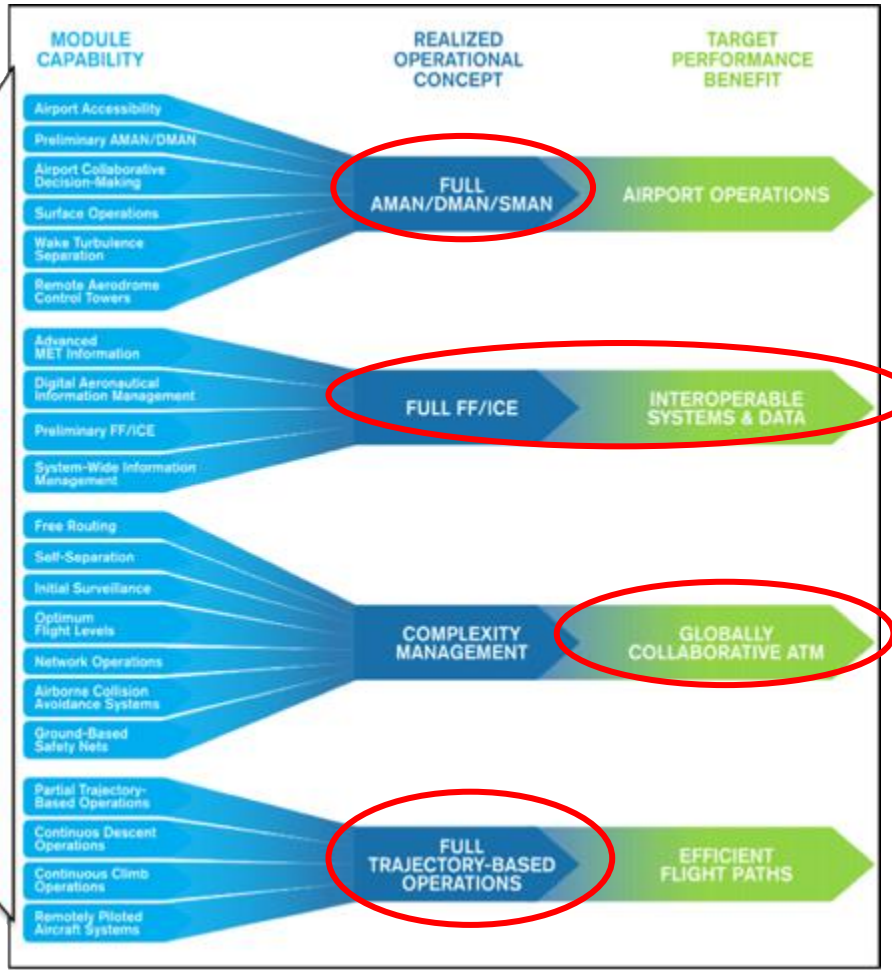
Digital Transformation[2]:

- ✓ The reworking of the products, processes and strategies within an organization by leveraging current technologies.

1 https://www.merriam-webster.com/dictionary/digital
2 https://searchcio.techtarget.com/definition/digital-transformation

Reworking Business-as-Usual

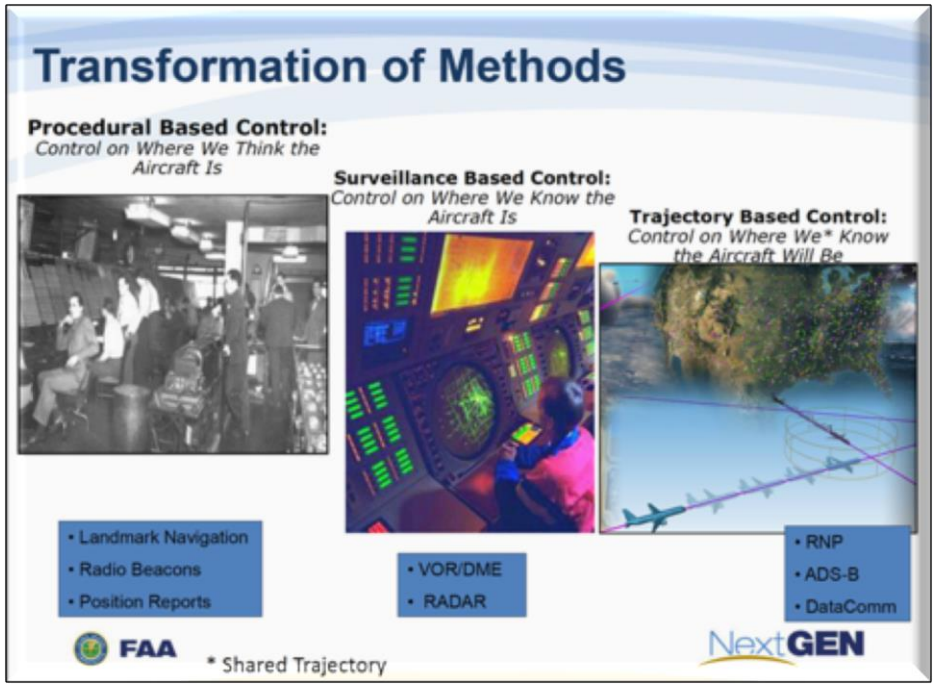
More data is better

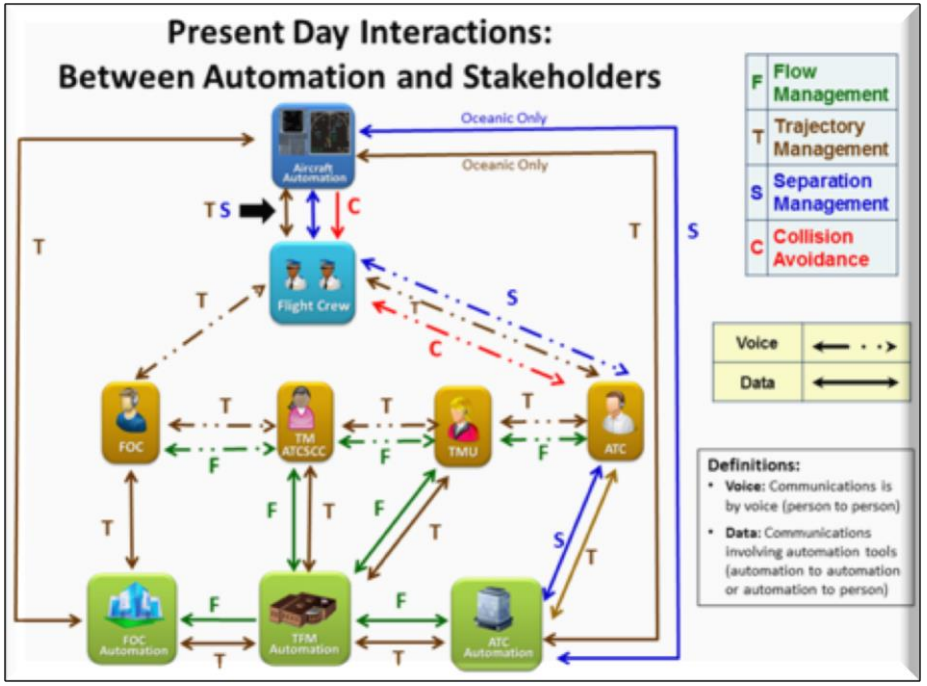


It will not get us there!

ICAO Global Air Navigation Plan (GANP) Document 9720

Rethinking ATM



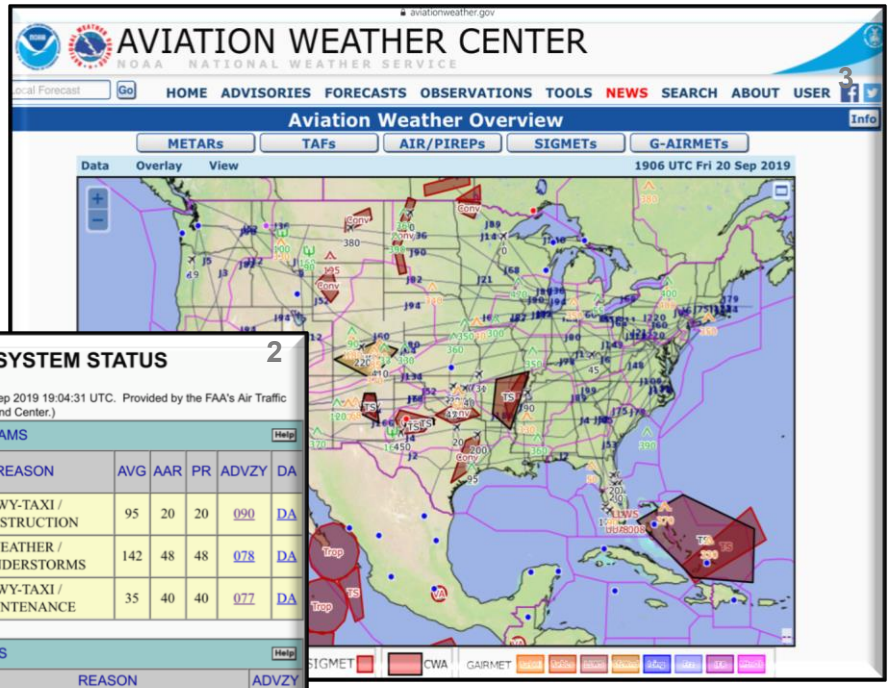


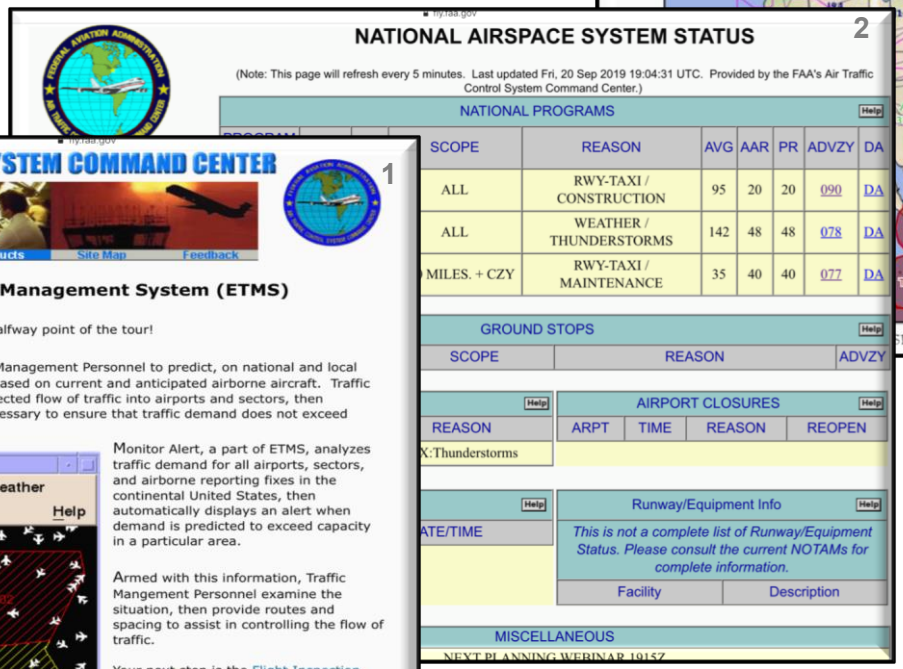
- **From voice driven instructions to automation augmented air traffic decision-making**
- **From where aircraft is to where it will be**

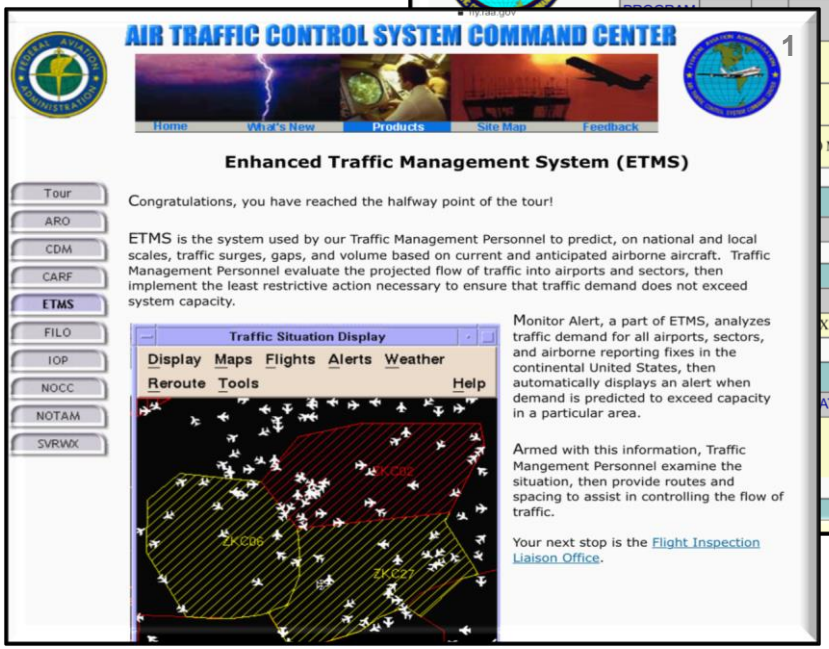
Steve Bradford, FAA, "Trajectory Based Operations in a Global Context. WAC 2015 Presentation. https://www.sesarju.eu/sites/default/files/documents/wac2015/Towards_global_interoperability.pdf

Assessing Where We Are

- **Where we started:**
  - CDM working with Industry
  - More Tools, More Data



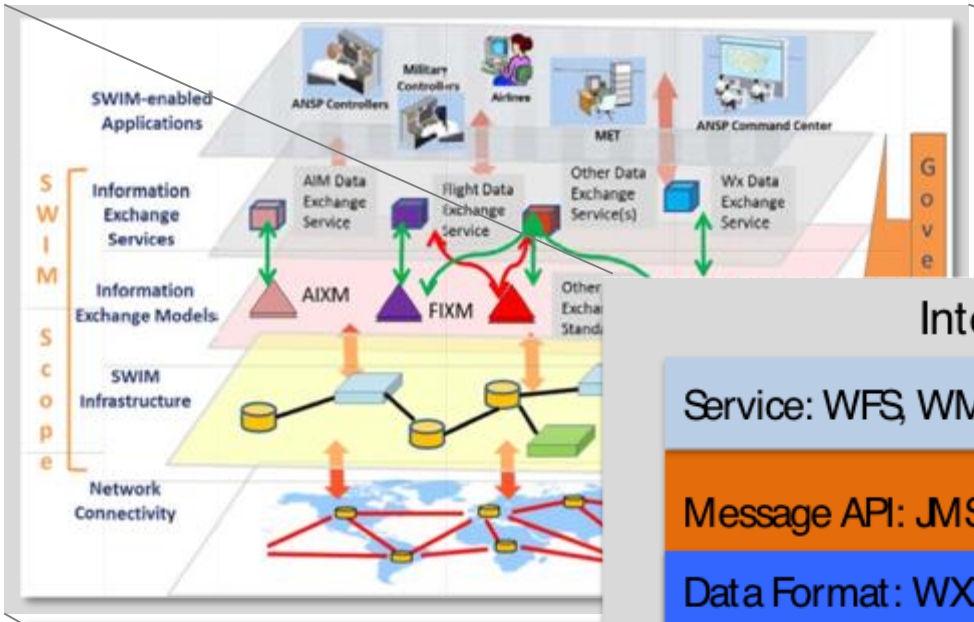




1 - https://www.fly.faa.gov/Products/Information/ETMS/etms.html
2 - https://www.fly.faa.gov/ois/
3 - https://www.aviationweather.gov

Standards Drive Interoperability

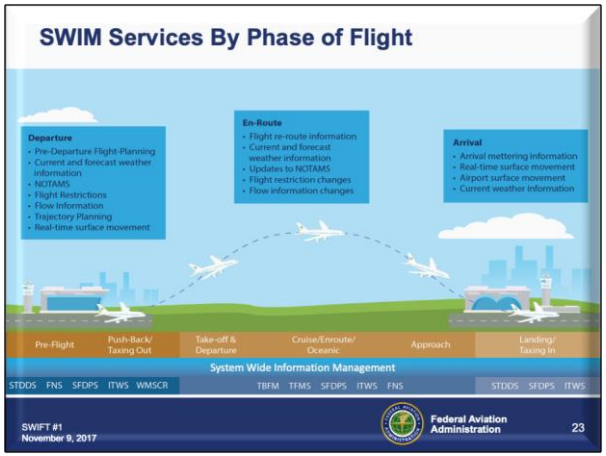
Interoperability: Ability of different IT systems & software applications to communicate, exchange data, and use the exchanged information

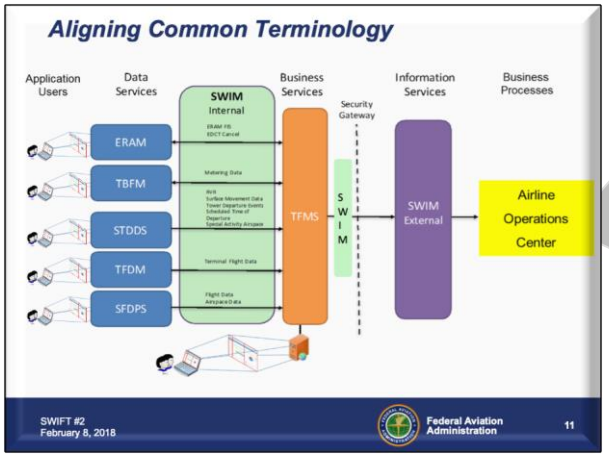


Interface Standards & Options

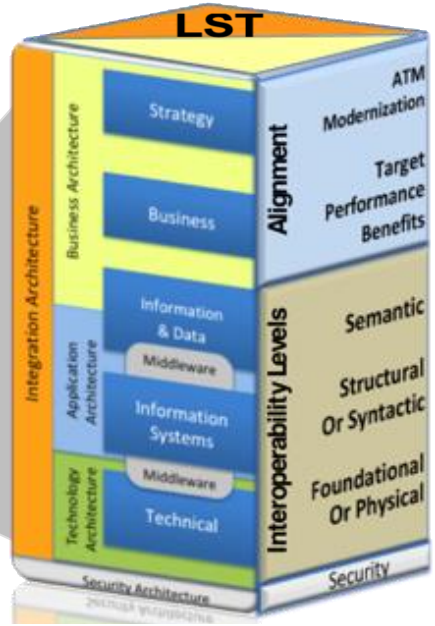
Service: WFS, WMS, WCS, Custom
Message API: JMS, SOAP, Rest, WSDL, WADL, .NET
Data Format: WXXM, FIXM, AIXM, IWXXM, FIXS, AIXS, WXXS
Message Format: XML, JSON, SOAP, JMS, MQTT, DDS, GML
Messaging Wire Protocol: AMQP, HTTP, MQTT, DDSI
Network Infrastructure: TCP/IP, DNS, NTP

Reworking Business Processes





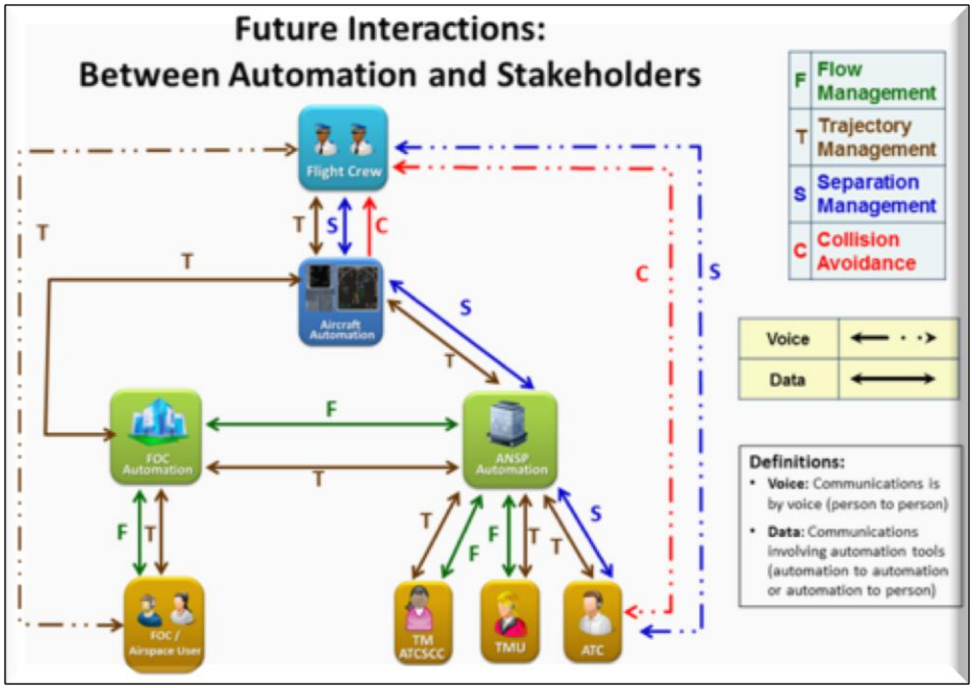
- **Business Strategy**
- **Business Processes/Metrics**
- **Technical Requirements**



Founded on Security Principles

Information Flows for Decisions

- **ATC is a human-centered business**
  - Greater collaboration between stakeholders
- **Data assimilated into decision-making**
- **Secure Exchange**
  - Criticality: Safety ??
- **Ground integration:**
  - ATC: ANSP to ANSP
  - AOC: Dispatch to FDP
- **Air-ground based:**
  - ATC: clearances
  - AOC: EFB, etc.



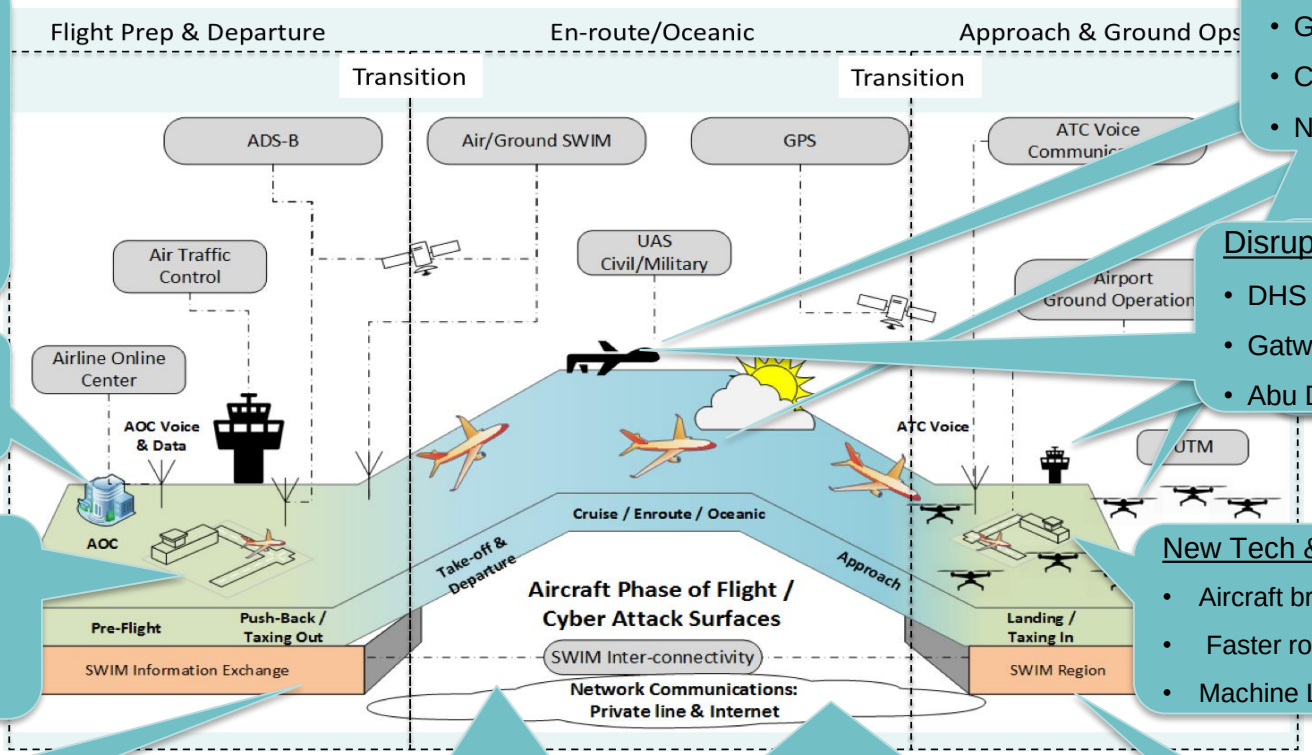
Steve Bradford, FAA, "Trajectory Based Operations in a Global Context. WAC 2015 Presentation. https://www.sesarju.eu/sites/default/files/documents/wac2015/Towards_global_interoperability.pdf

The Goals and Challenges Ahead

Goals & Needs:
- More capacity
- More automation
- More integration
- Resiliency
- Federated IAM
- "Negotiation Net"

Disruptions:
- Aerodata, Saber
- United, Delta

New Tech:
- Airport Beacon and NOTAMS
- A/C Maintenance blockchain by Aeron



New Capabilities:
- Greater Capacity
- Connected Aircraft
- New entrants

Disruptions:
- DHS 757 Comms
- Gatwick 50M£
- Abu Dhabi $3M/30 mins

New Tech & Ops:
- Aircraft breaking (IoT)
- Faster routing to gate
- Machine Learning

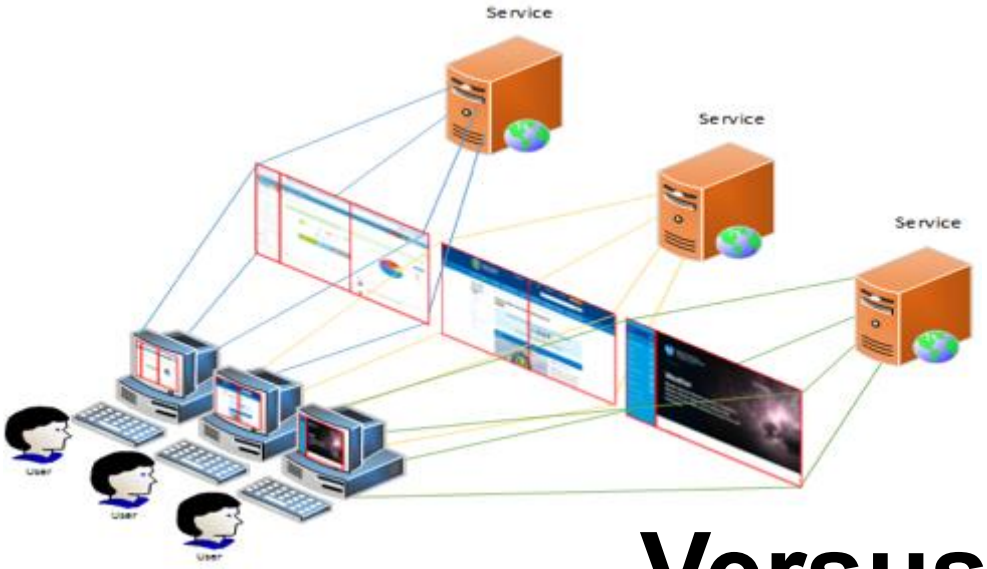
Key Network Features:
- Access Control, Authenticate
- Availability
- Credentials, Certificates

Trust Framework:
- Define Cybersecurity Global Governance
- Harmonize Specifications Development
- Establish global federated hub

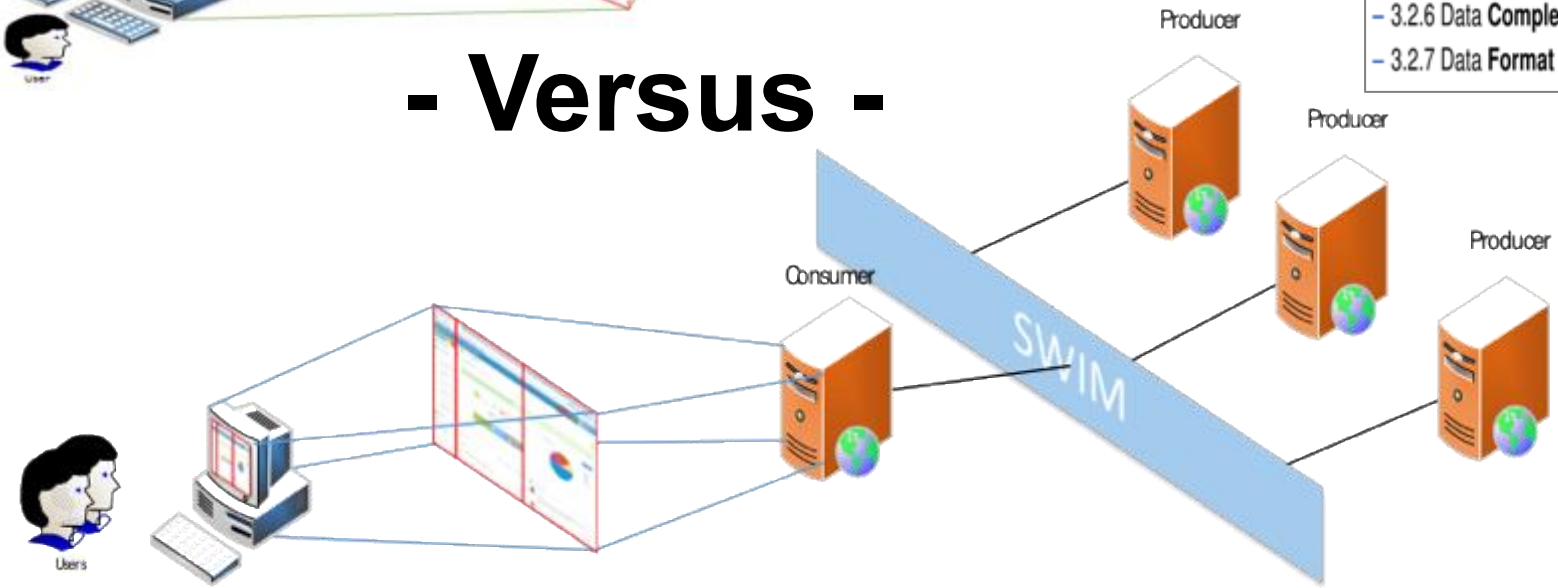
Best Practices:
- Robustness and scalable for growth
- Built on open standards: interoperable
- Independently assessed, audited & enforced
- Cost effective: open to market forces

Key Data Features:
- Data Integrity
- Authorization
- Transport Security

Rethinking Solutions



- Versus -

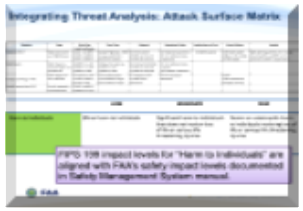


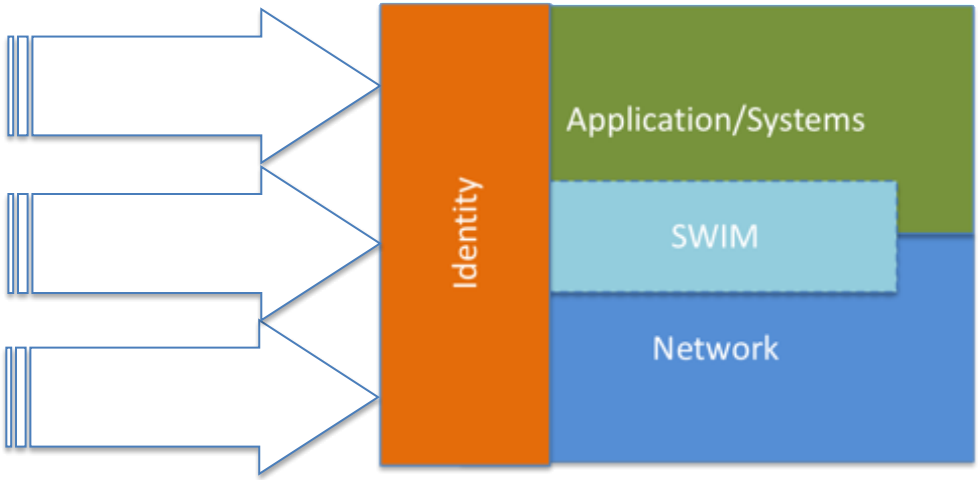
Layered Security Approach

Use Case Development

Operational Scenario Analysis

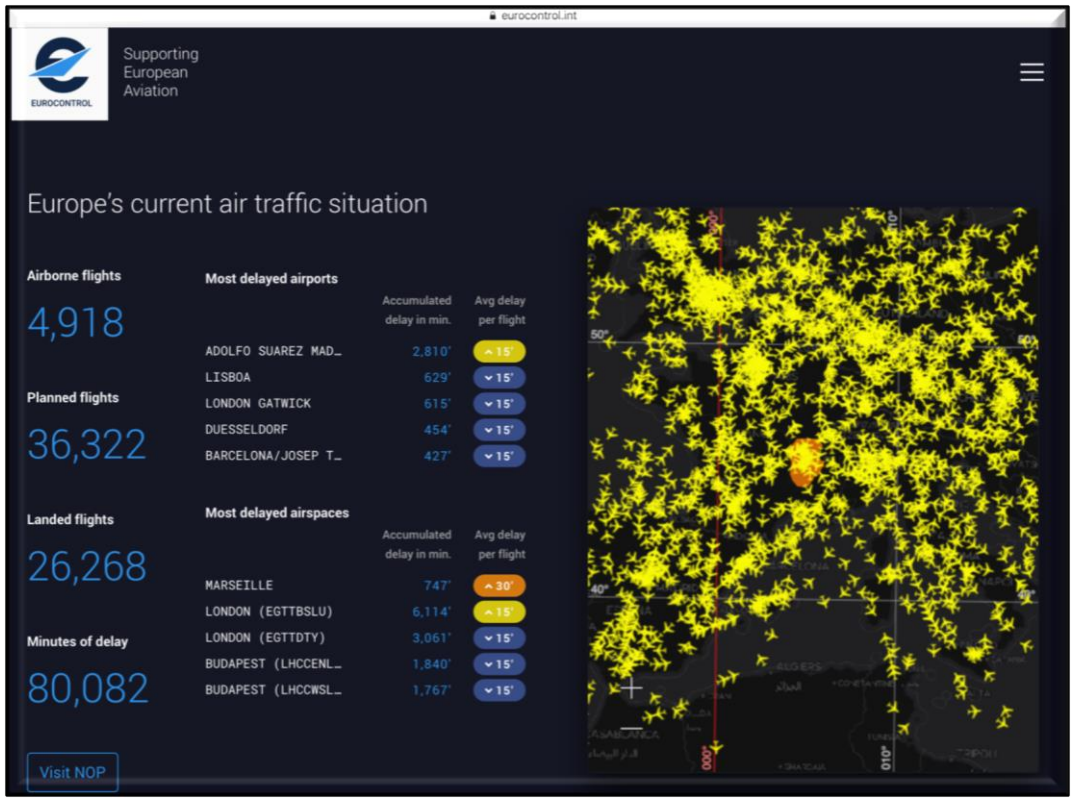
Threat Matrix





Good: Better Situational Awareness

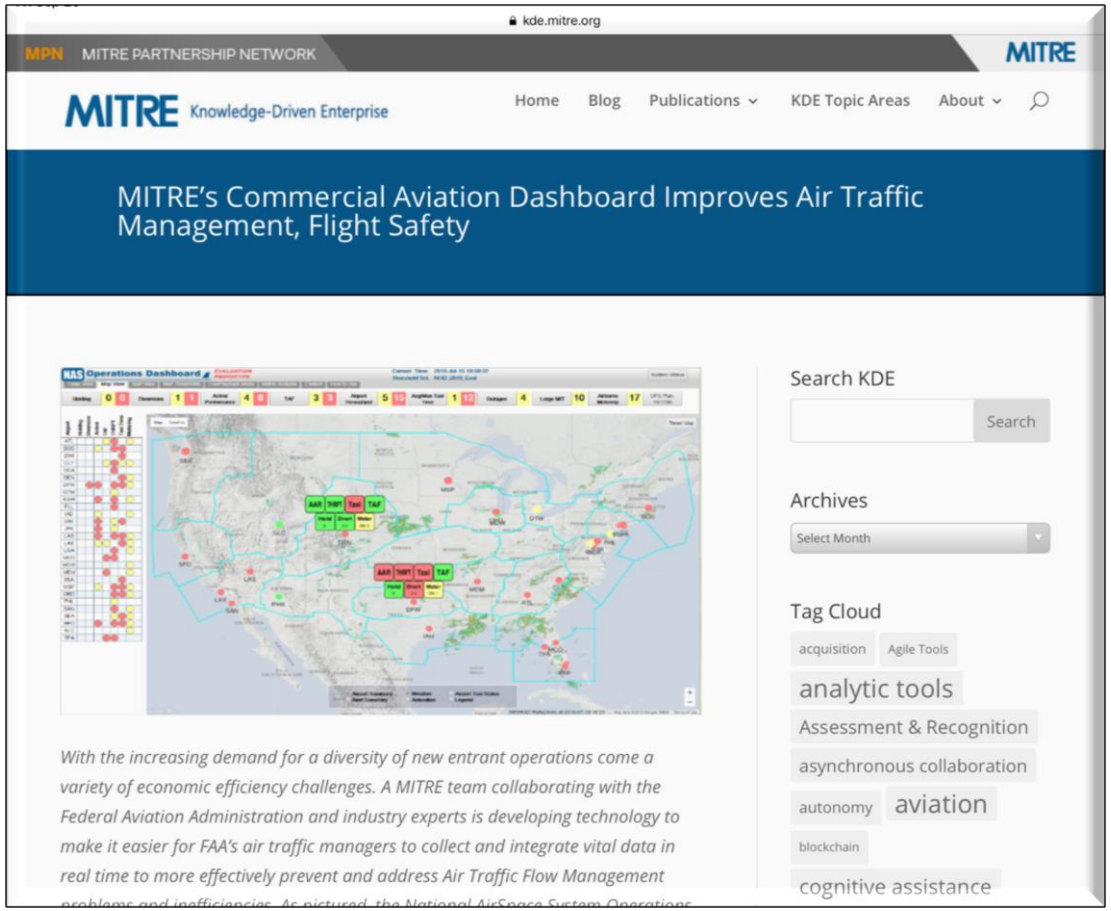
- **Integrates other applications**
- **Offers decision-makers insights**
- **Provides current operational picture**
- **Easy to monitor traffic situation**



"Europe's Current Air Traffic Situation", Eurocontrol: https://www.eurocontrol.int

Better: Integrated Dashboards

- **Browser-based dashboard**
- **Integrates tools, single application**
- **Ingests multiple data sources**
- **Leverages SWIM metering service (TBFM), others…**



Commercial Aviation Dashboard, Mitre Corporation, 2017.
https://kde.mitre.org/blog/2017/06/29/mitres-commercial-aviation-dashboard-improves-air-traffic-management-flight-safety/

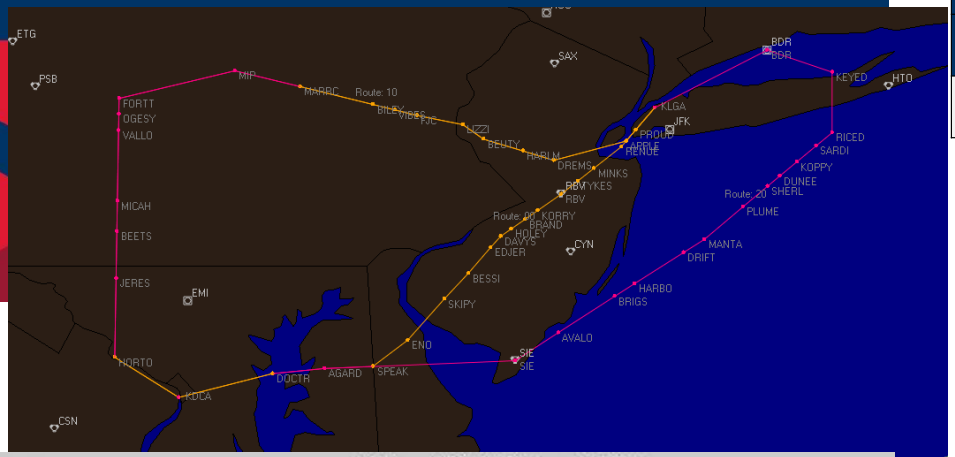
Best: Informed Decisions, Use Case

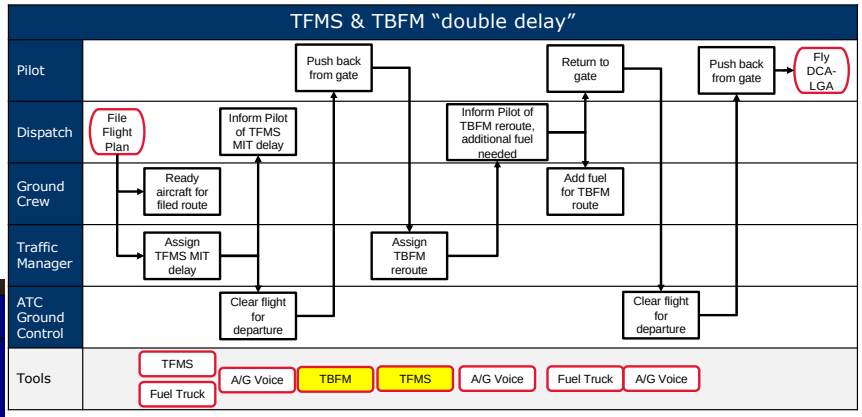
DELTA

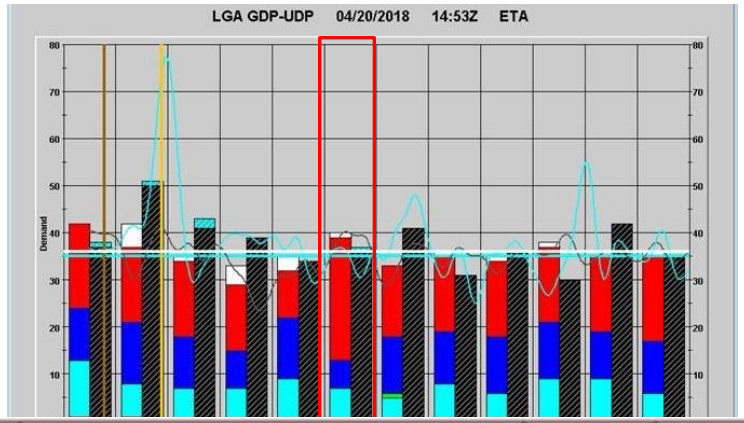
Originally presented
Bill Tuck
Delta Airlines
May 10, 2018

Aviation Case Study:

"Taxi out, Return to Gate"







LGA 04/11/2018 17:00Z

Current Info
Data: Arrivals
Filter(s): RBV AND ETA between 11/1900 and 11/1959

	ACID	TYPE	ORIG	IGTD	LGTD	OUT	ETD	TMA-RT	CTD	ETA	ASLO
1	EDV3975	CRJ2	ORF	11/1650	11/1650	11/1648	M11/1744	11/1744	-	L11/1900	-
2	AAL2066	A321	CLT	11/1706	11/1706	-	M11/1732	11/1732	-	L11/1900	-
3	N300R	G280	DAB	11/1700	11/1655	-	L11/1700	-	-	L11/1903	-
4	AAL1366	B738	MIA	11/1626	11/1622	11/1622	A11/1639	-	-	E11/1905	-
5	RPA6140	E170	DCA	11/1700	11/1700	11/1654	M11/1806	11/1806	-	L11/1905	-
6	RPA4607	E75L	ATL	11/1655	11/1654	11/1654	T11/1719	-	-	L11/1908	-
7	DAL1586	A320	ATL	11/1730	11/1730	-	L11/1732	-	-	E11/1910	-

REQUESTING	PROVIDING	RESTRICTION	START TIME	STOP TIME
N90	EWR/LGA	WHITE 5MINIT JETS EXCL: ZDC LTFC 1245-1615 N90 EWR,LGA	04/20/2018 1245	04/20/2018 1615
N90	HPN/TEB	WHITE 7MINIT JETS EXCL: ZDC LTFC 1245-1615 N90 TEB,HPN	04/20/2018 1245	04/20/2018 1615
N90	PHL/ZBW/ZDC/ZNY/ZOB	EWR TBM 4R 1400-0200 N90 ZNY,ZOB ZDC,ZBW,PHL	04/20/2018 1400	04/21/2018 0200
N90	ZBW	LGA VALRE,NOBBI 15MIT PER ROUTE 1101-0300 N90 ZBW	04/20/2018 1101	04/21/2018 0300
N90	ZDC	LGA RBV 15MIT 1101-0300 N90 ZDC	04/20/2018 1101	04/21/2018 0300
N90	ZNY	LGA LIZZI 15MIT 1101-0300 N90 ZNY	04/20/2018 1101	04/21/2018 0300

"Taxi Out, Return to Gate" , Bill Tuck, Delta Airlines, SWIFT #3, May 8, 2018
https://www.faa.gov/air_traffic/technology/swim/swift/media/SWIFT%20Meeting%203%20Presentation%20Slides%2010%20May%202018%20(TM%20final).pdf

30 Min Outlook

60 Min Outlook

GAYEL COATE DEEZZ NEWEL ZIMMZ BIGGY

ZIMMZ BIGGY RBV BEADS WHITE

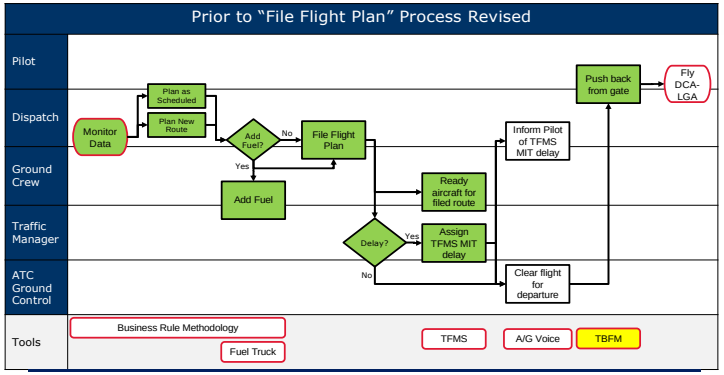
Over Capacity

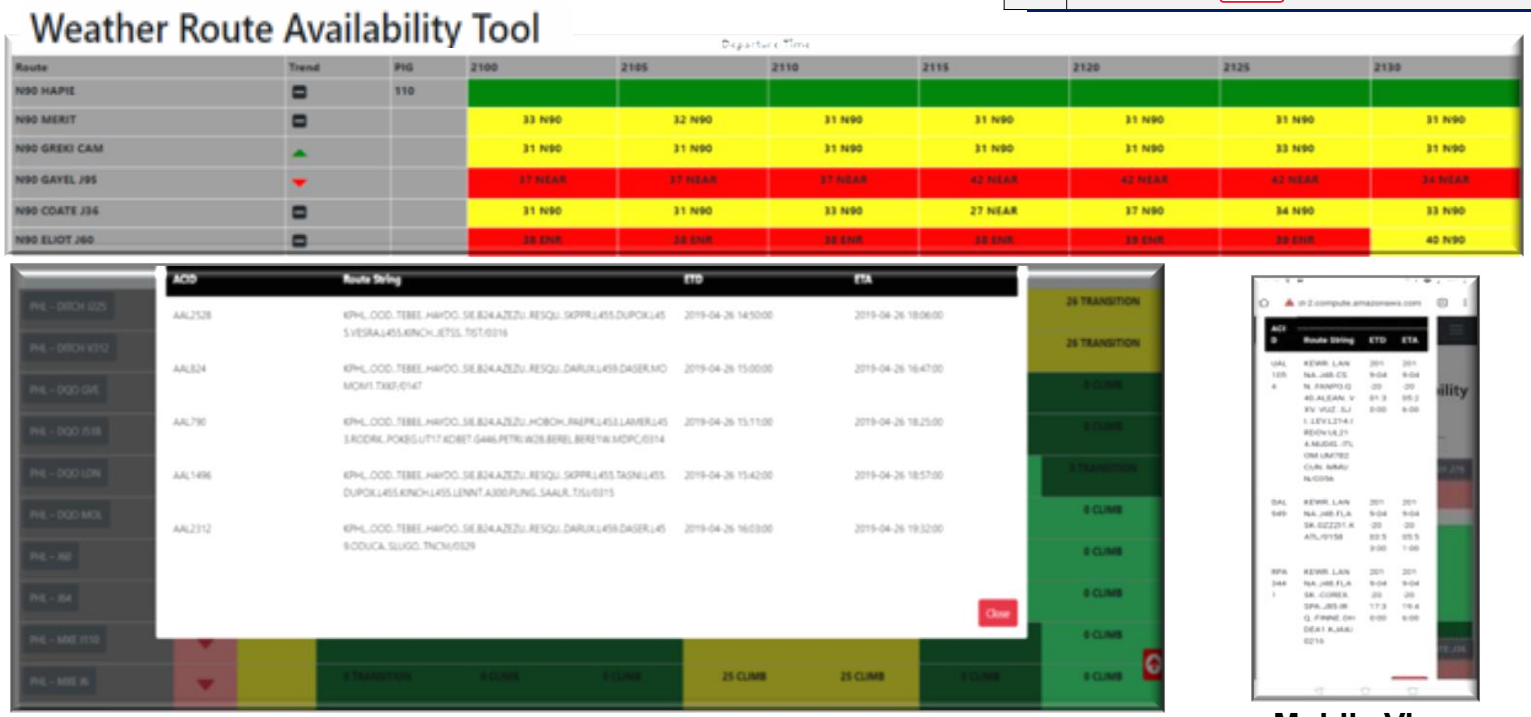
Near Capacity

Below Capacity

"Art of the Possible"

- **New Approach**
  - New Sources, New Tools





Desktop View

Mobile View

https://www.faa.gov/air_traffic/technology/swim/swift/media/SWIFT%20Meeting%203%20Presentation%20Slides%2010%20May%202018%20(TM%20final).pdf

Conclusions

- **ATM making great strides in digitalization**
  - SWIM deployments and information services
  - Service oriented architecture (SOA)…a start!
- **Change "analog" workflows to digital that representing change in business-as-usual**
  - Legacy users continue pursue efficiencies…re-invent!
  - New entrants never had "analog" workflows
- **Invest and research in "trust" technologies**
- **Result: fundamental transformation required to achieve ATM Modernization**