AI *in a SMART* *AI*rport

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Changi Airport : Our Terminals

- Four main passenger terminals at Changi (82 Million passenger capacity)
  - Terminal 1: Opened in 1981, refurbished in 1995, recently completed upgrading
  - Terminal 2: Opened in 1990, upgraded in 2006
  - Terminal 3: Opened in 2008
  - Terminal 4: Opens on Oct 31 2017 (16 MPPA)

Opens 2018: Mixed-use complex, incorporating aviation, retail & leisure.

- Singapore's largest indoor garden and vortex
- Fusion of nature and retail space

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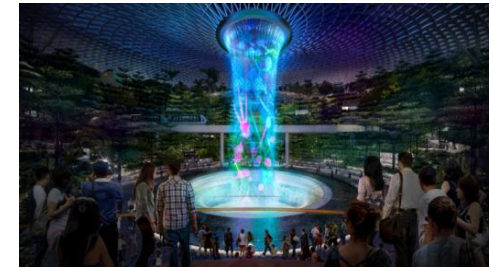
Many partners, many missions, ONEChangi

200+ organisations

10,000 frontline staff

40,000 staff

1,800 CAG staff

Creating a service ecosystem

To provide **160,000** customers ONEChangi experience every day

# Changi is a Complex System of Systems

INTERNATIONAL LINKS

- Activities include Airport Operations, Commercial, Air Hub & Emergency Services.

- Four Terminals with floor area > **1,000,000 m²** with > **70,000 m²** of retail space.

- **58.7 million** passengers annually.

- **A flight every 90 seconds.** 107 scheduled airlines, 380 city links to 90 countries.

How to handle the Diversity, Complexity & Scale?

Can AI really solve all our problems? Ask Siri or Alexa.

AI has been around.
So what is different now?
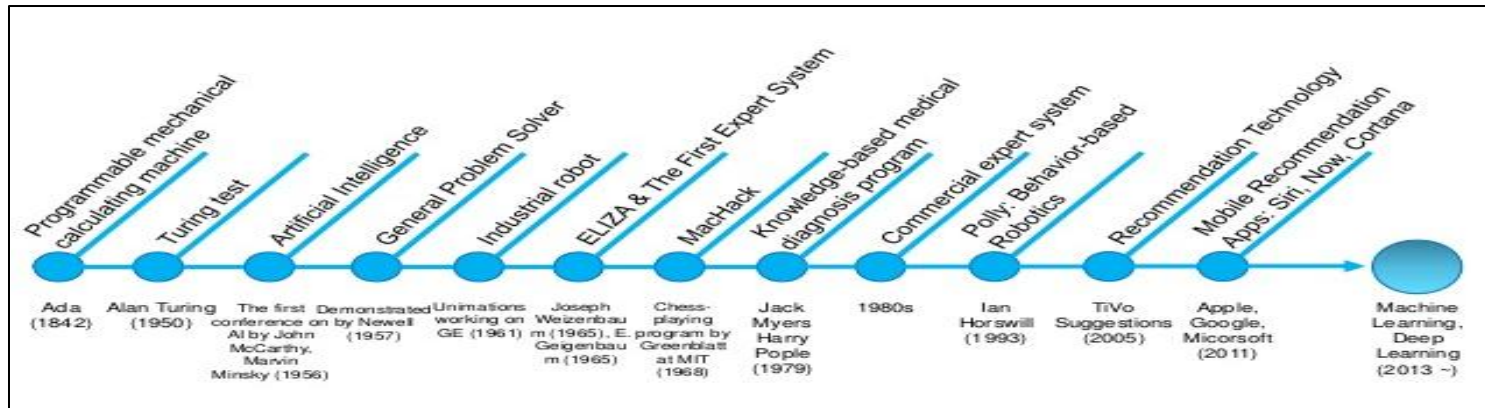
I have been following "AI" since last wave circa 1982…

Heuristics in Search	Evans & Sunderland GPU for simulators	Local Optimisation e.g. Genetic Algorithms, Neural Nets	Autolisp in Autocad
Image Recognition for military applications	Expert Systems Simulation & Ops Analysis	Turbo Prolog : Chess, Language Interface, Knowledge Representation	
OpenGl and Vector based "language" for graphics display across narrow band networks		Programming Text Adventure Games, Experiments in ELIZA	Smalltalk & other interesting "grammars"

Access to massive amounts of usable data through sensors & massive computing power easily available.

CAG is investing in AI to improve/transform
Challenge in past few years was access to usable data

- Airport Service and Retail
  - **Ops Anticipation – Example of Arrival Journey**
  - Retail / Customer Genome
  - Customer Engagement Channels
    - Chatbots
    - Language Translation to help service staff and our digital channels
- Security & Safety
  - Image Recognition
  - Analytics applications

Must always answer "How can we improve the lives of our customers and employees?"

Journey of Arriving Passengers

Takeoff
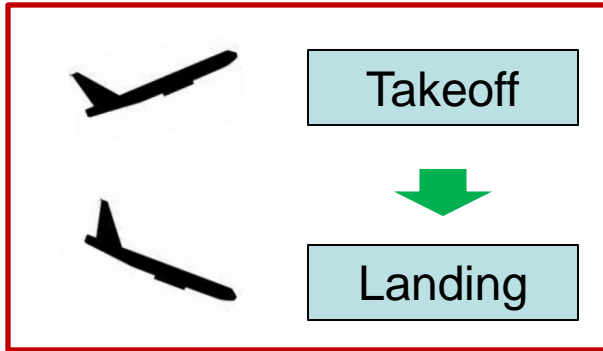
Has the plane taken off?
How many people are on board?

Important to predict landing time due to downstream impact.

Landing

How early can we know its predicted landing time?
Any possible congestion on arrival e.g. stand conflict?

At Gate

When will it reach the stand? Enough trolleys?
Any potential immigration queue issue?

Immigration

Any possible congestion on arrival?
Right number of resources deployed?

Baggage Claim

Bags unloaded on time? Distance from stands?
Any possible congestion at claim hall?

Taxi Queue

Predicted taxi demand? Taxi queue buildup?
Taxi supply situation – need to activate?

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Every day 1,000 flights take off and land in Changi airport from all over the world carrying 160,000 passengers
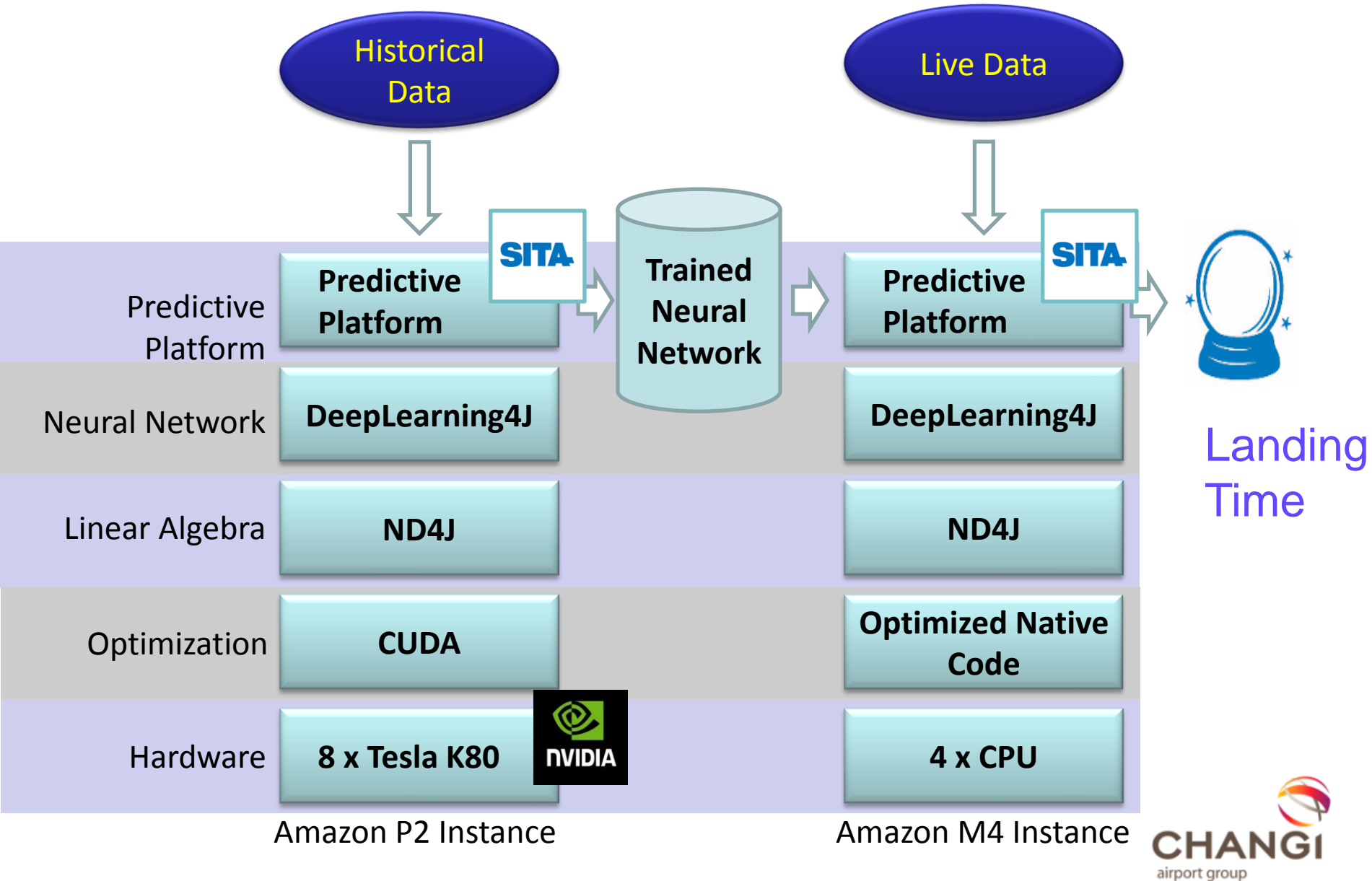
Predicting Landing Time : AI problem
We adopted a "Hybrid" approach

- Input data:
  - ADS-B location information
  - Flight data from open sources
  - Air Traffic Information e.g. runway in use direction, standard terminal arrival routes (STARS) chosen
  - Weather information e.g. bad weather or wind direction
  - Flight information e.g. aircraft type, pax
  - Actual landing time

- Output data:
  - Predicted landing times upon takeoff
  - Predicted landing times (2 hours away from actual landing time)
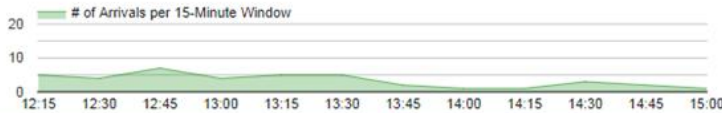
We partnered with SITA to set this up.

	Historical Data		Trained Neural Network	Live Data	
Predictive Platform	**Predictive Platform**	SITA		**Predictive Platform**	SITA
Neural Network	**DeepLearning4J**			**DeepLearning4J**	
Linear Algebra	**ND4J**			**ND4J**	
Optimization	**CUDA**			**Optimized Native Code**	
Hardware	**8 x Tesla K80**	NVIDIA		**4 x CPU**	
	Amazon P2 Instance			Amazon M4 Instance	

Landing Time

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Some Technical Points

- Predictive platform is based on machine learning, hence it is split into two modules; a learning model (on the left) and the real-time predictive module (on the right).

- The neural network implementation that we use is provided by DeepLearning4J. DeepLearning4J is supported by ND4J, which is a high performance linear algebra library.

- ND4J is very portable and flexible. It allows us to reduce the training time of the neural network.

- Need to be able to have quick and easy access to GPU computing power. We can re-train our neural network very frequently, and in this way continuously improve the prediction accuracy.

Based on current training improvement, a usable model can be ready in a few months' time

User Interface is important for AI development

Live Demo

Improving passengers and employees' lives through landing prediction:

- Improved information sharing with meeters and greeters
- Improved resource allocation for all touchpoints especially aircraft turnaround
- Arrival trolleys fulfillment
- Minimise stand conflicts
- **Reducing immigration queue**
- Improving taxi queue demand forecast

The better estimate is necessary for improvement but not sufficient. Other measures are needed e.g. concept of operations changes.

Another Possible AI Project

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At Gate

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Immigration

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Right number of resources deployed?

Predict possible immigration queue buildup
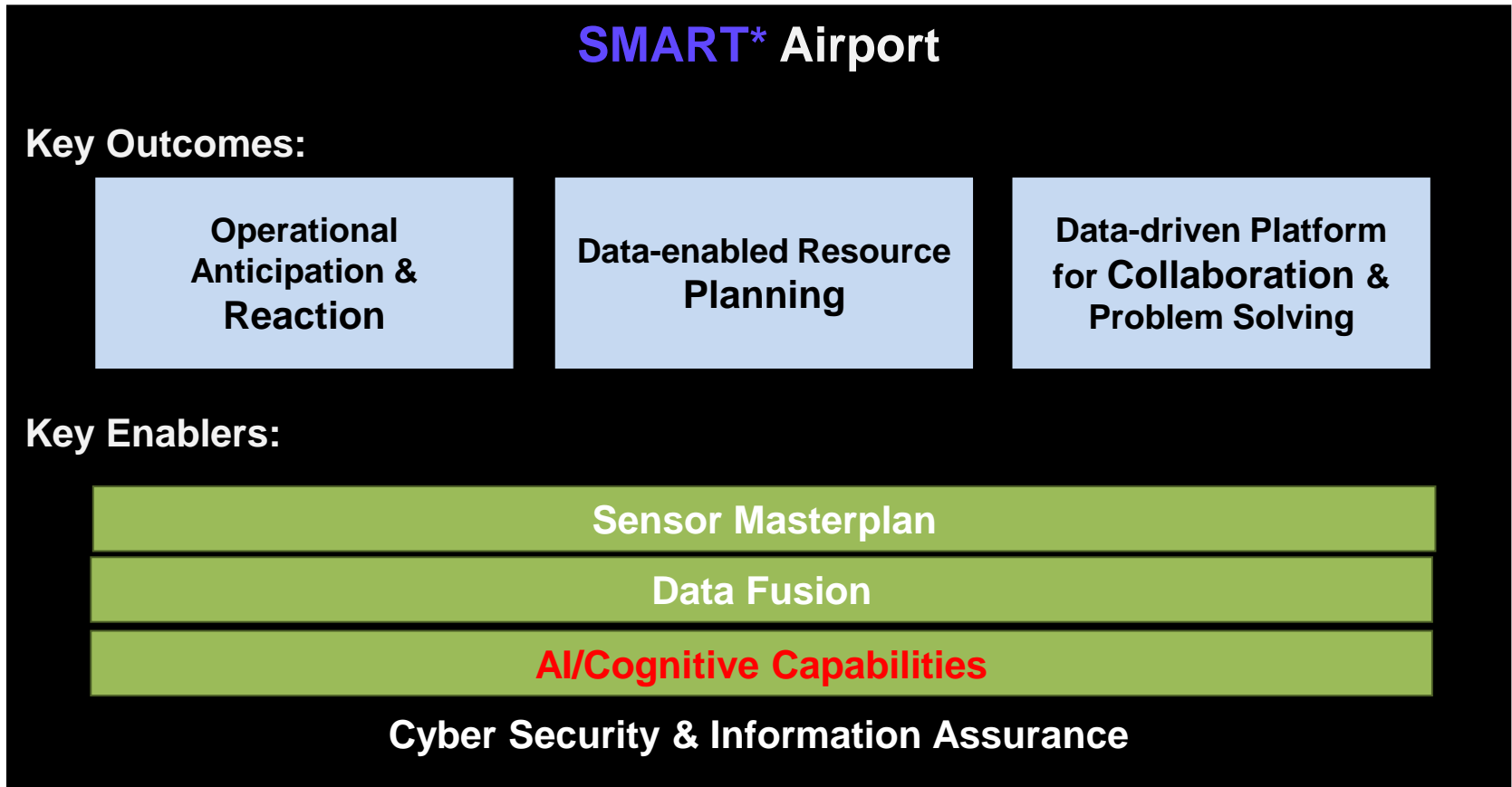
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Bags unloaded on time? Distance from stands?
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AI *is a key enabler in a SMART* AI*rport

SMART* Airport

Key Outcomes:

Operational Anticipation & Reaction	Data-enabled Resource Planning	Data-driven Platform for **Collaboration & Problem Solving**

Key Enablers:

Sensor Masterplan

Data Fusion

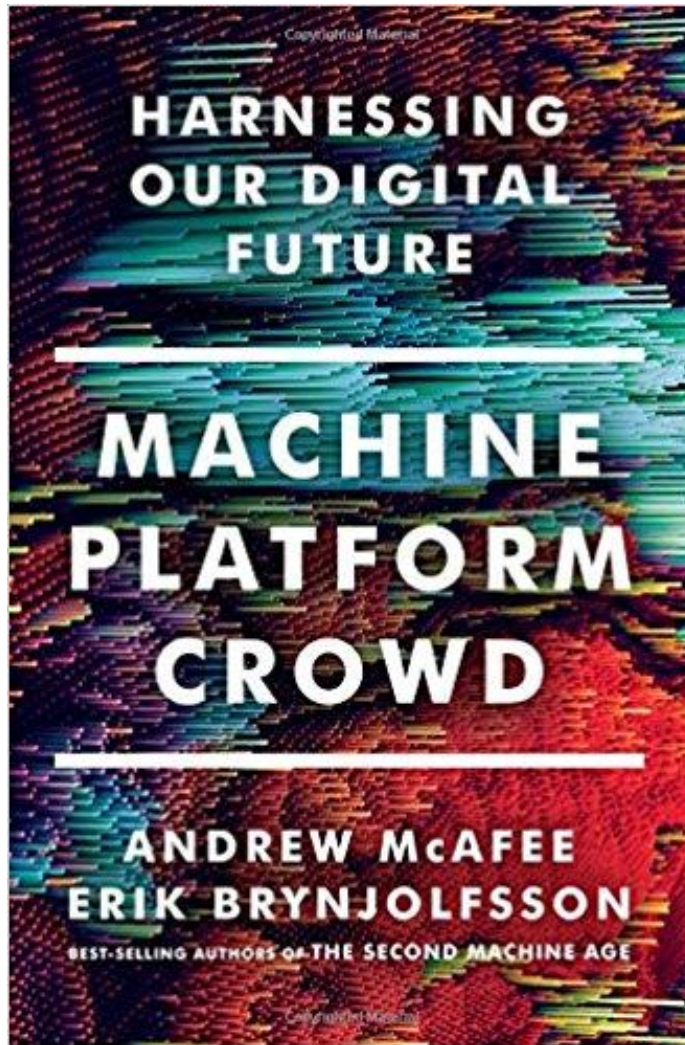**AI/Cognitive Capabilities**

Cyber Security & Information Assurance

*SMART : Service, **S**afety and **S**ecurity **M**anagement through **A**nalytics and **R**esource **T**ransformation

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SMART Airport :
Smart People augmented by AI

Thanks!

Recommended to me by Steven Miller, Vice Provost (Research) and immediate past dean School of Information Systems, Singapore Management University.