Future Systems Directorate

DSTA
Defence Science & Technology Agency

An Experiment in Machine-Augmented Sensemaking in Intelligence Analysis

Gwenda Fong
Future Systems Directorate

Keith Oh
Defence Science & Technology Agency

Future Systems Directorate

Overview

DSTA
Defence Science & Technology Agency

- Problem Statement
- Theoretical Models
- Risk Assessment and Horizon Scanning System
- The Experiment
  - Overview
  - Scenario
  - Task
  - Design
- Results and Discussion of Findings
- An Observation
- Conclusions
- The Way Ahead

Future Systems Directorate

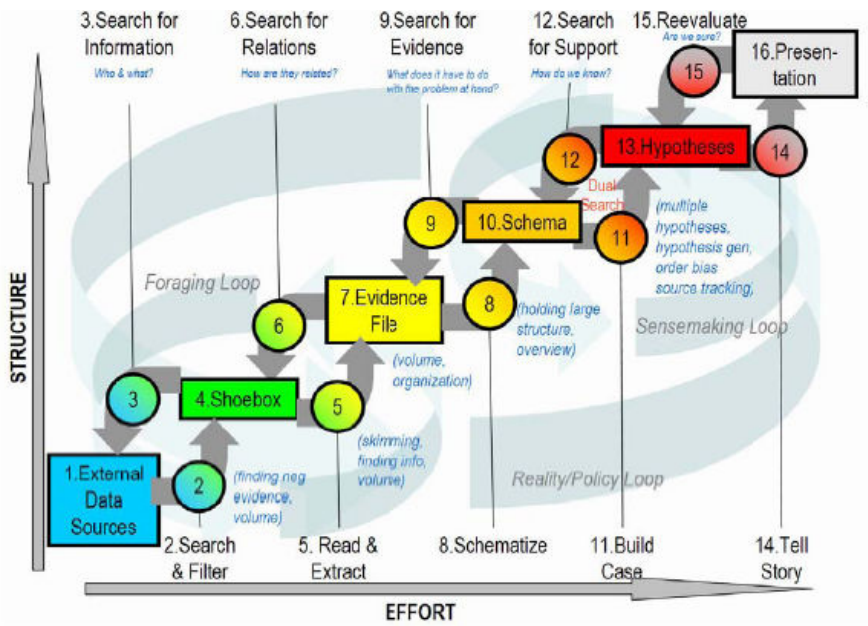
Problem Statement

DSTA
Defence Science & Technology Agency

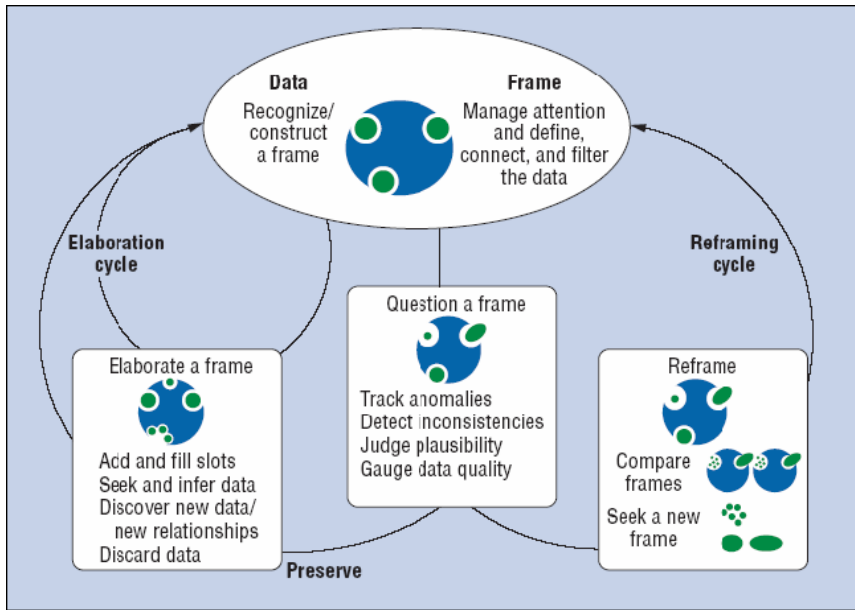
Future Systems Directorate

Theoretical Models

DSTA Defence Science & Technology Agency



Pirolli and Card (2005)



Klein, Moon, Hoffman (2006)

- Top-down: predetermined hypotheses drive information search
- Bottom-up: data drives hypotheses formation
- Iterative and tightly coupled
- Focus not just on data, but also metadata and relationships
- Can we build a sensemaking system to help analysts visualize the patterns that exist in the dataset?

Future Systems Directorate

Motivations

DSTA
Defence Science & Technology Agency

"In the longer term, we need to establish a risk-assessment and horizon-scanning capability to anticipate strategic surprises…

… Uncertainty and unpredictability are the key challenges, and our focus will be on anticipating surprises…"

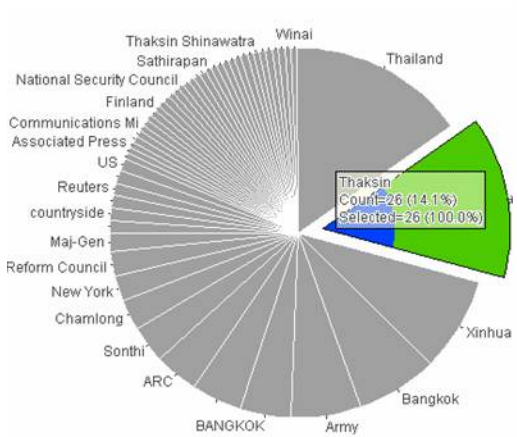
The Fight Against Terror:
Singapore's National Security Strategy, 2004

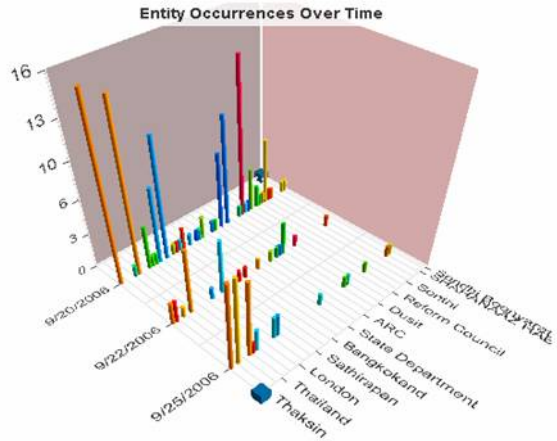
Future Systems Directorate

RAHS System

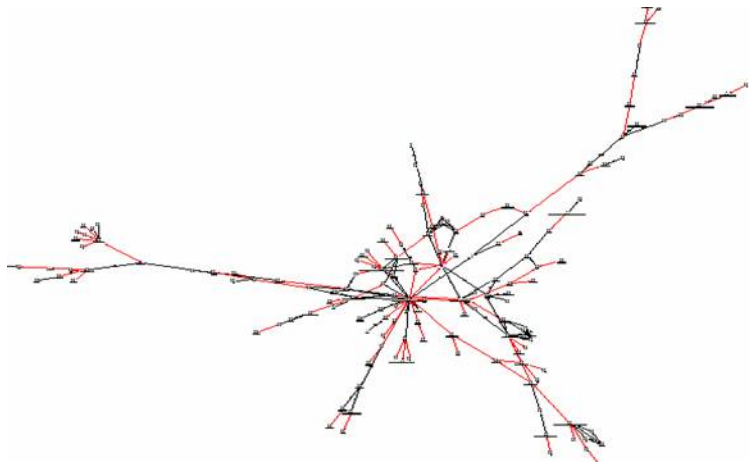
DSTA
Defence Science & Technology Agency

- Search
- Clustering
- Duplicate Detection
- Summarization
- Keyword Analysis
- Entity Analysis
- Entity Network
- Timeline Analysis
- Question and Answering





Entity Analysis



Entity Network

Doctor's Note

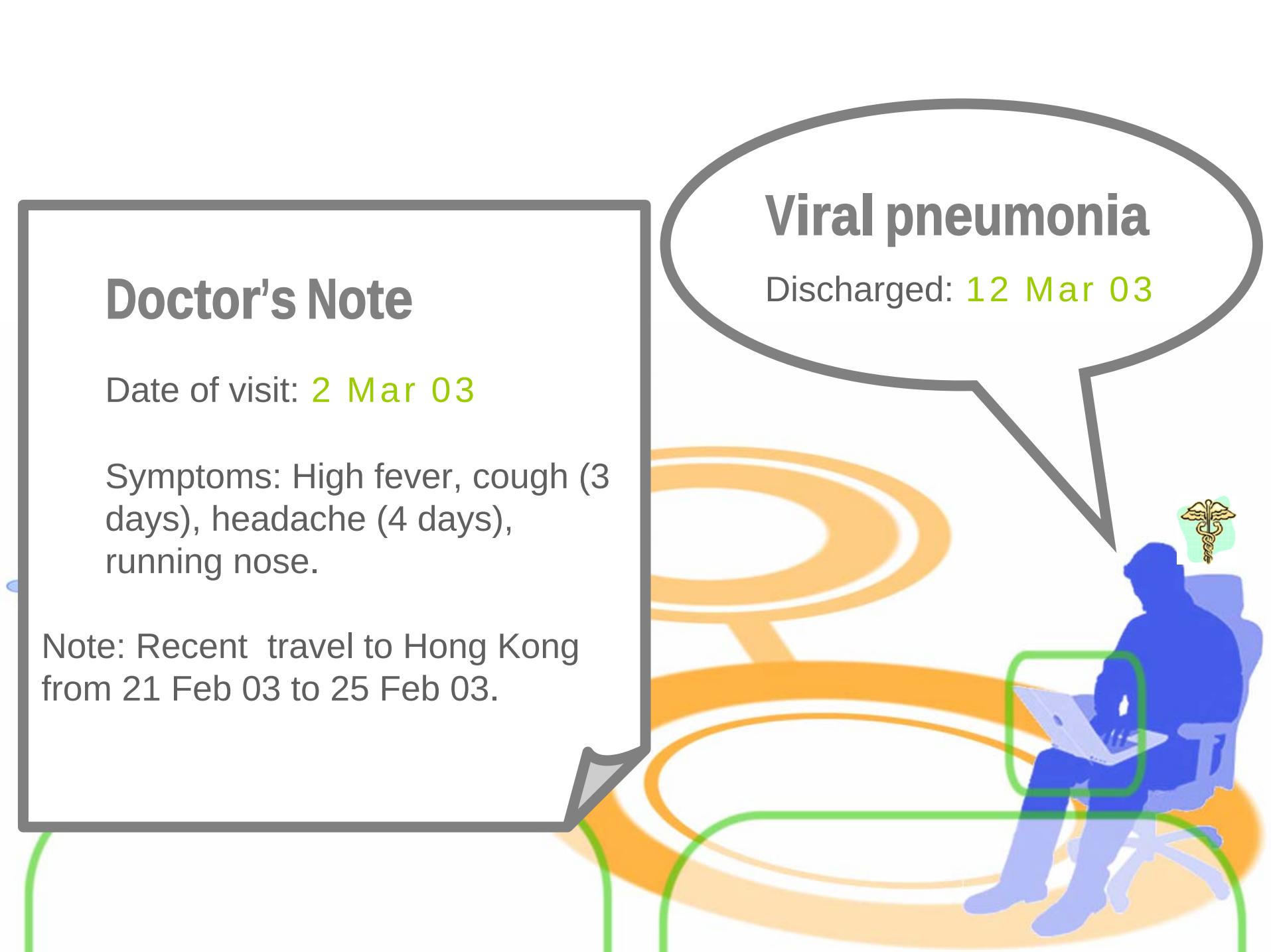
Date of visit: 2 Mar 03

Symptoms: High fever, cough (3 days), headache (4 days), running nose.

Note: Recent travel to Hong Kong from 21 Feb 03 to 25 Feb 03.

Viral pneumonia

Discharged: 12 Mar 03



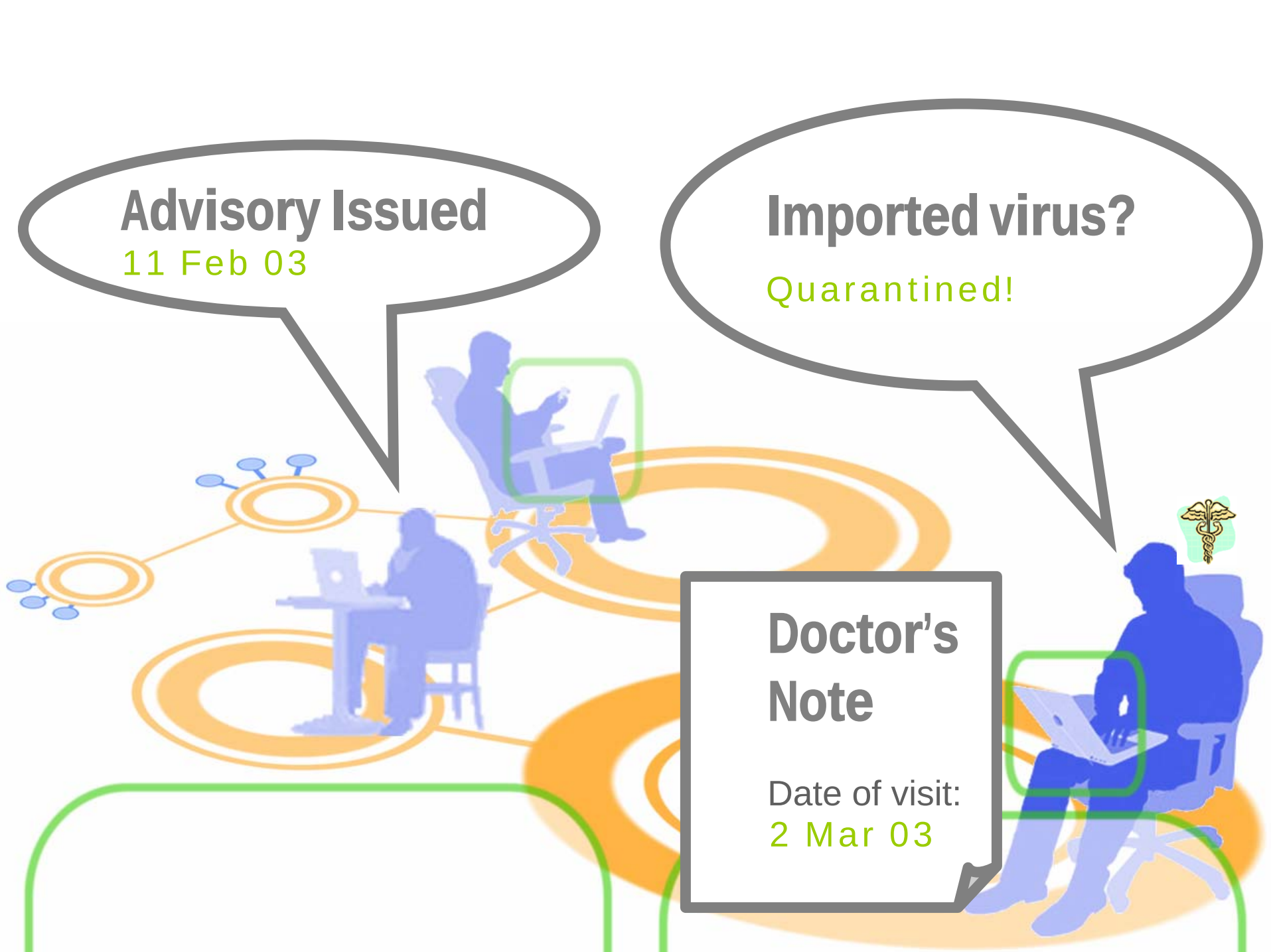
RAHS Data Alert

Article

Source: http://service.china.org.cn

Date: 11 Feb 03

"… Authorities in southern China's Guangdong province called for emergency measures to combat a mysterious lung virus that has so far stricken 305 people and killed five, officials said Tuesday…"

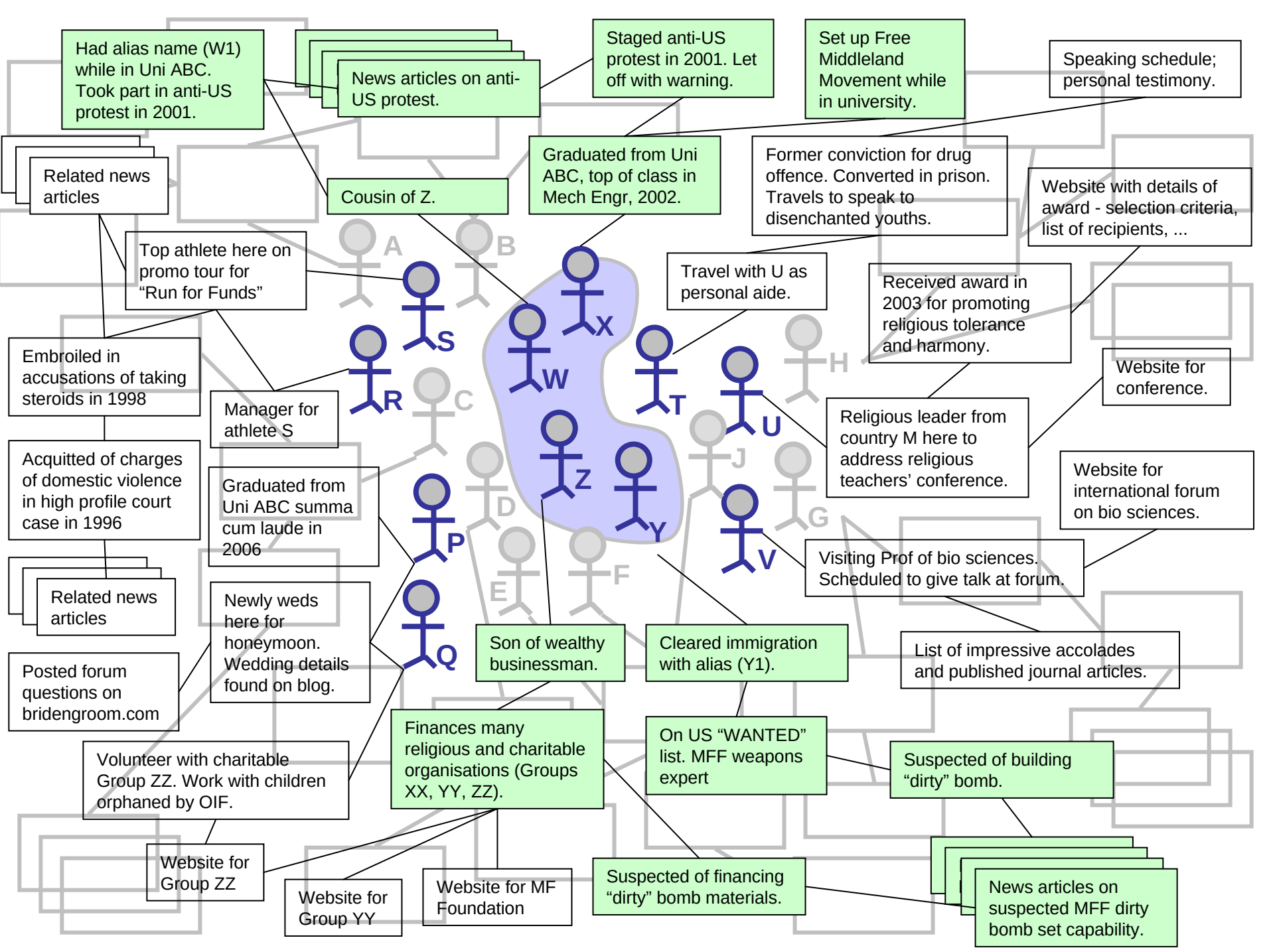

Advisory Issued
11 Feb 03
Imported virus?
Quarantined!
Doctor's Note
Date of visit:
2 Mar 03

Future Systems Directorate

Experiment Overview

DSTA
Defence Science & Technology Agency

- **Limited Objective Experiment**
  - Aimed at concept discovery
  - Involved only 4 participants
  - Part of a larger experiment involving approx 130 officers
- **Scenario**
  - Larger experiment involved having the participants plan to establish a Zone of Security in fictitious terrain
  - Contend with terrorist group in addition to traditional military threat
- **Task**
  - Search through database of >100 documents to piece together information on the terrorist organization


Had alias name (W1) while in Uni ABC. Took part in anti-US protest in 2001.
News articles on anti-US protest.
Staged anti-US protest in 2001. Let off with warning.
Set up Free Middleland Movement while in university.
Speaking schedule; personal testimony.
Related news articles
Cousin of Z.
Graduated from Uni ABC, top of class in Mech Engr, 2002.
Former conviction for drug offence. Converted in prison. Travels to speak to disenchanted youths.
Website with details of award - selection criteria, list of recipients, ...
Top athlete here on promo tour for "Run for Funds"
Travel with U as personal aide.
Received award in 2003 for promoting religious tolerance and harmony.
Embroiled in accusations of taking steroids in 1998
Manager for athlete S
Website for conference.
Acquitted of charges of domestic violence in high profile court case in 1996
Graduated from Uni ABC summa cum laude in 2006
Religious leader from country M here to address religious teachers' conference.
Website for international forum on bio sciences.
Related news articles
Newly weds here for honeymoon. Wedding details found on blog.
Visiting Prof of bio sciences. Scheduled to give talk at forum.
Posted forum questions on bridengroom.com
Son of wealthy businessman.
Cleared immigration with alias (Y1).
List of impressive accolades and published journal articles.
Volunteer with charitable Group ZZ. Work with children orphaned by OIF.
Finances many religious and charitable organisations (Groups XX, YY, ZZ).
On US "WANTED" list. MFF weapons expert
Suspected of building "dirty" bomb.
Website for Group ZZ
Website for Group YY
Website for MF Foundation
Suspected of financing "dirty" bomb materials.
News articles on suspected MFF dirty bomb set capability.
A
B
C
D
E
F
G
H
J
S
R
X
W
T
U
Z
Y
P
Q
V

Future Systems Directorate

Experiment Design

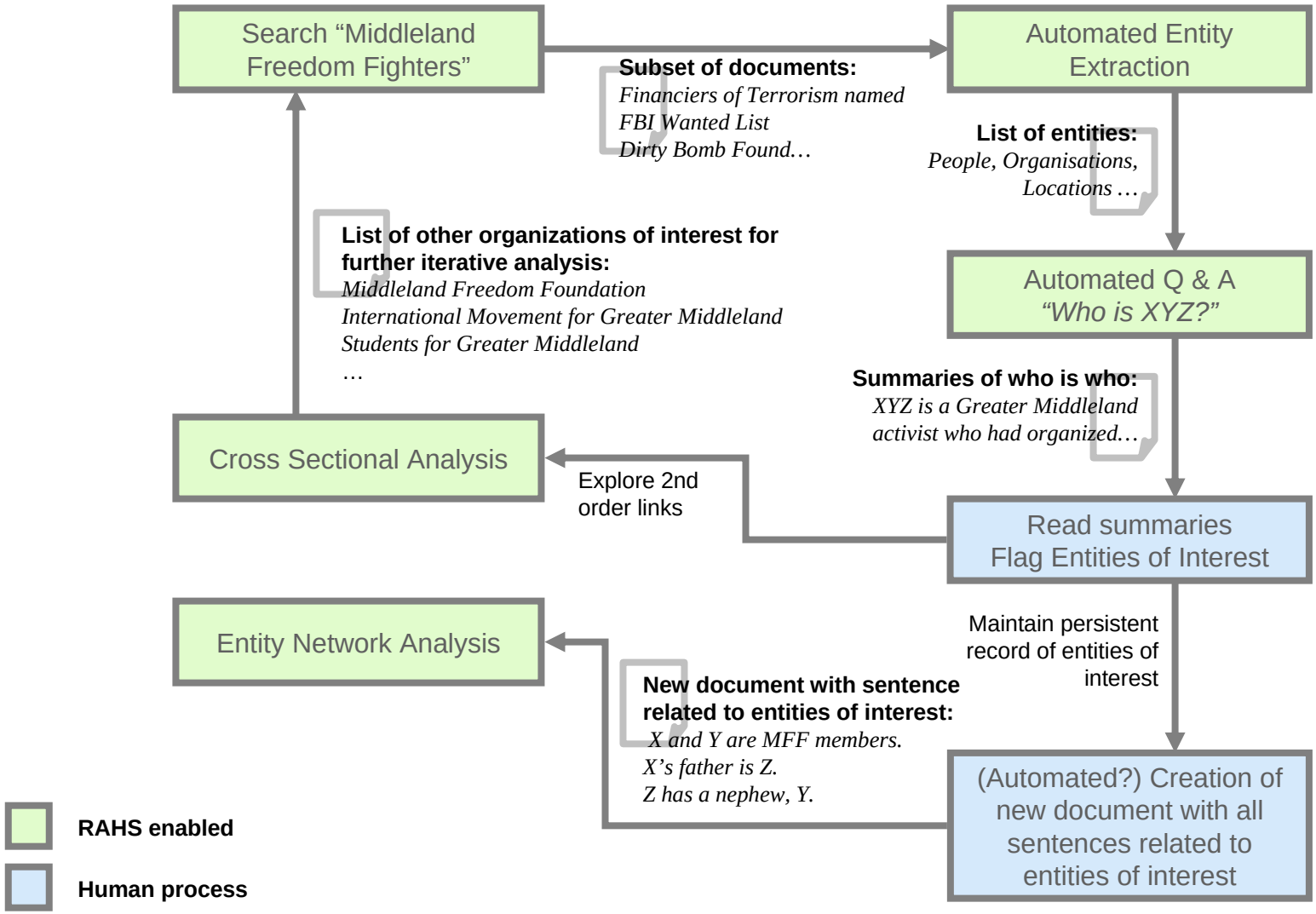
DSTA
Defence Science & Technology Agency

- Independent variable: Search Engine vs RAHS
- Dependent variable 1: Accuracy of intelligence analysis
  - Answer series of 10 questions after 150min
  - 6 “strong signal” questions + 4 “weak signal” questions
- Dependent variable 2: Workflow process
  - Screenshots taken at between 3 – 6 sec intervals
  - Used to derive usage patterns (e.g. frequency, average and total duration spent on each activity)
- Participants: 2 RAHS analysts vs 2 search engine analysts
- Expectations

Future Systems Directorate

Conceptual RAHS workflow

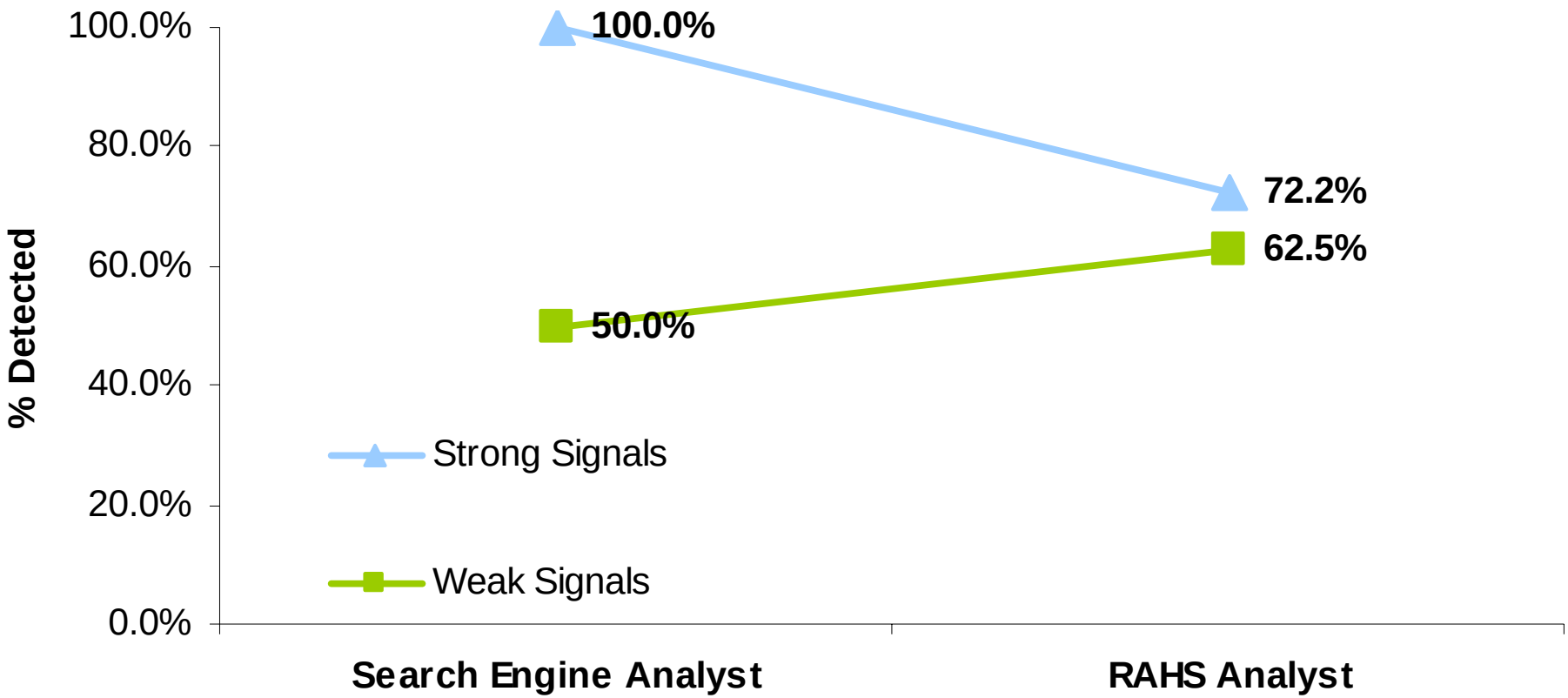
DSTA Defence Science & Technology Agency



Future Systems Directorate

DSTA
Defence Science & Technology Agency

Results / Discussion (1)
Accuracy of Intelligence Analysis



Future Systems Directorate

Results / Discussion (1)
Accuracy of Intelligence Analysis

DSTA Defence Science & Technology Agency

- Search Engine analyst: *narrow but in-depth* paradigm
  - Read individual documents returned from search query
  - Benefit of appreciating context of each document
  - Limited number of documents covered under time pressure
  - Cross-document inference dependent on understanding / memory
  - Able to correctly answer all “strong signal” questions but did poorly in answering “weak signal” questions
- RAHS analyst: *broad but cursory* paradigm
  - Automated Q&A feature helped in picking out key sentences across subset of documents related to search query
  - Facilitated analyst’s linking of information across several documents
  - Over-reliance on summaries; missed out on larger context
  - Missed out on answering some “strong signal” questions while did better in answering “weak signal” questions

Future Systems Directorate

Results / Discussion (2)
Workflow Process

DSTA Defence Science & Technology Agency

Screenshot Activity	Frequency		Average time spent		Total time spent	
	Search Engine	RAHS	Search Engine	RAHS	Search Engine	RAHS
Search	125	6	10.6 sec	157 sec (2.6 min)	22.1 min	15.7 min
Reading of documents	169	0	15.0 sec	-	42.3 min	-
Compilation of Info	75	19	12.6 sec	140 sec (2.3 min)	15.8 min	44.5 min
RAHS Entity Analysis	-	7	-	165 sec (2.7 min)	-	19.2 min
RAHS Automatic Q&A	-	18	-	72 sec (1.2 min)	-	21.5 min

Extract of results for comparison

Future Systems Directorate

Results / Discussion (2) Workflow Process

DSTA Defence Science & Technology Agency

- Different profiles of workflow process

- A lot less switching between activities by RAHS analyst
  - A sign that RAHS had automated and collapsed some of the iterative information foraging loops displayed by the Search Engine analyst?
  - RAHS facilitated entity analysis across subset of documents
  - Automatic Q&A further made salient the entities of interest

- Flipside: RAHS analysts tended to hone in on single workflow
  - Obtained initial answers early on, yet they soon reached a saturation point
  - Should have challenged themselves to constantly expand information foraging strategy

Future Systems Directorate

Conclusions

DSTA
Defence Science & Technology Agency

- Not able to make inferential statistical comparisons
- However, data elucidates significant differences in workflow processes as facilitated by respective tools
- Likely to have contributed to differences in quality of intelligence analysis with regard to “strong” and “weak” signals
- Desired outcome is to have team of analysts develop balanced heuristic to leverage strengths of both paradigms

Future Systems Directorate

The Way Ahead

DSTA
Defence Science & Technology Agency