

Forensic Issues Regarding the Analysis of Evidence in Support of Agroterrorism Investigations



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Topics



- Overview of forensic science and admissibility.
- The importance of quality assurance and validation.
- Challenging property of most terrorism investigations.
- Existing partnerships and organizations.
- The task ahead.
- Some new technologies to address the needs.



Forensic Science



- Application of science in the investigation of legal matters
- “*Forensis*” (*L.*) – open debate (forum)
- Scientific knowledge and technology are used to serve as witnesses in both criminal and civil matters.
 - Science may not offer definitive solutions for all scenarios; it can provide a special investigative support.
 - Individual vs. class evidence – fingerprints vs. ABO
 - “It is what it is”



Adversary System



Judge

Lawyer

Witness





Legal Standards for Admissibility of Scientific Evidence



- Frye test (1923)
- Daubert test (1996)
- Federal Rules of Evidence
- Specific statutes



Frye v. United States, 293 F. 1013 (D.C. Cir. 1923)



“...scientific evidence will not be admissible unless it has been generally accepted by the scientific community...”



3 Prongs of *Frye*

1. Has the underlying scientific theory gained general acceptance in the scientific community?
2. Has the scientific technique gained general acceptance in the pertinent scientific community?
3. Were proper test procedures employed in this case?



What Constitutes General Acceptance?



- Scientific Literature
- Presentations at Scientific Meetings
- General Use of the Technology
 - In other fields?
 - In other forensic applications?
 - Concordance of results demonstrated by proficiency testing?
- Expert Testimony



Daubert

Daubert v. Merrill Dow Pharmaceuticals, Inc.
1996

Judge is given a “Gatekeeping” Responsibility:

“In order to admit scientific evidence, the trial court judge must find that the opinion offered is **relevant** and that the basis for that opinion is more likely than not **valid and reliable.**”



Daubert

Daubert v. Merrill Dow Pharmaceuticals, Inc.
(1996)



- Four non-exclusive factors:
 - Testability
 - Peer Review
 - Error Rate
 - General Acceptance



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Elements of a Quality Forensic Program



- Appropriate facilities (dedicated and properly configured).
- Validated Protocols (interpretation / admissibility).
- Personnel: Training, Testing, Certification.
- Accreditation and/or demonstrated compliance with established guidelines.
- Demonstrated proficiency.
- Sufficient relevant knowledge and experience to interpret forensic data and provide investigative support.



Quality Assurance Guidelines for Laboratories Performing Microbial Forensic Work

Forensic Science Communications, *Vol. 5, No. 4, October, 2003*
http://www.fbi.gov/hq/lab/fsc/backissu/oct2003/2003_10_guide01.htm



- **Quality Assurance Program**
- **Organization and Management**
- **Personnel**
- **Facilities**
- **Sample Control**
- **Validation**
- **Analytical Procedures**
- **Equipment Calibration and Maintenance**
- **Reports and Review of Reports**
- **Proficiency Testing**
- **Corrective Action**
- **Audits**
- **Safety**
- **Subcontracting**



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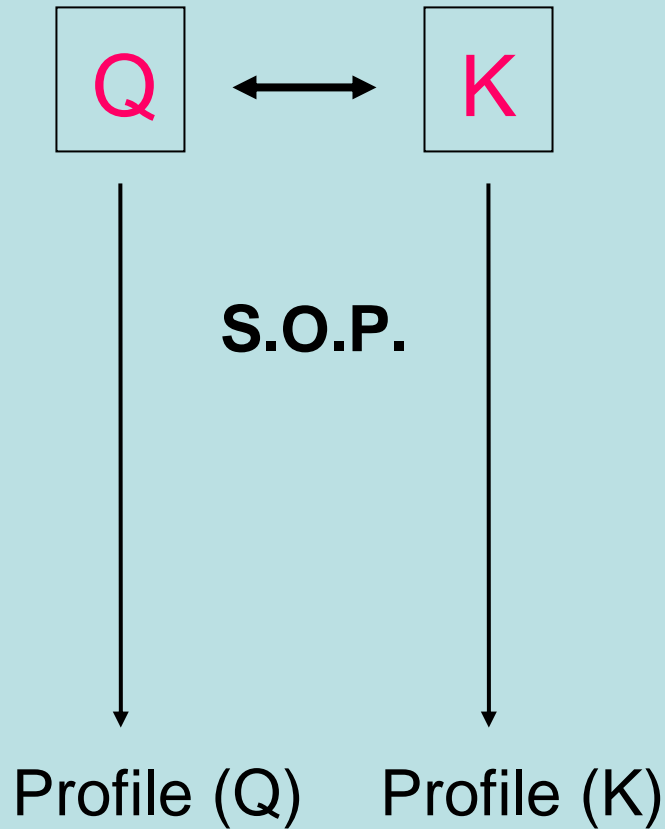
Forensic Practices



- A comparison is made of the data obtained from the evidence sample(s) with that obtained from analysis of a reference sample(s) **Q vs. K**
- Each discipline has distinct “match criteria”
(interpretation of data)
- Unique identification of the sample and thus its ultimate source or origin is desired....
- In many cases that may not be possible.



Traditional Forensic Typing





Traditional Forensic Typing (cont.)

Profile **Q**

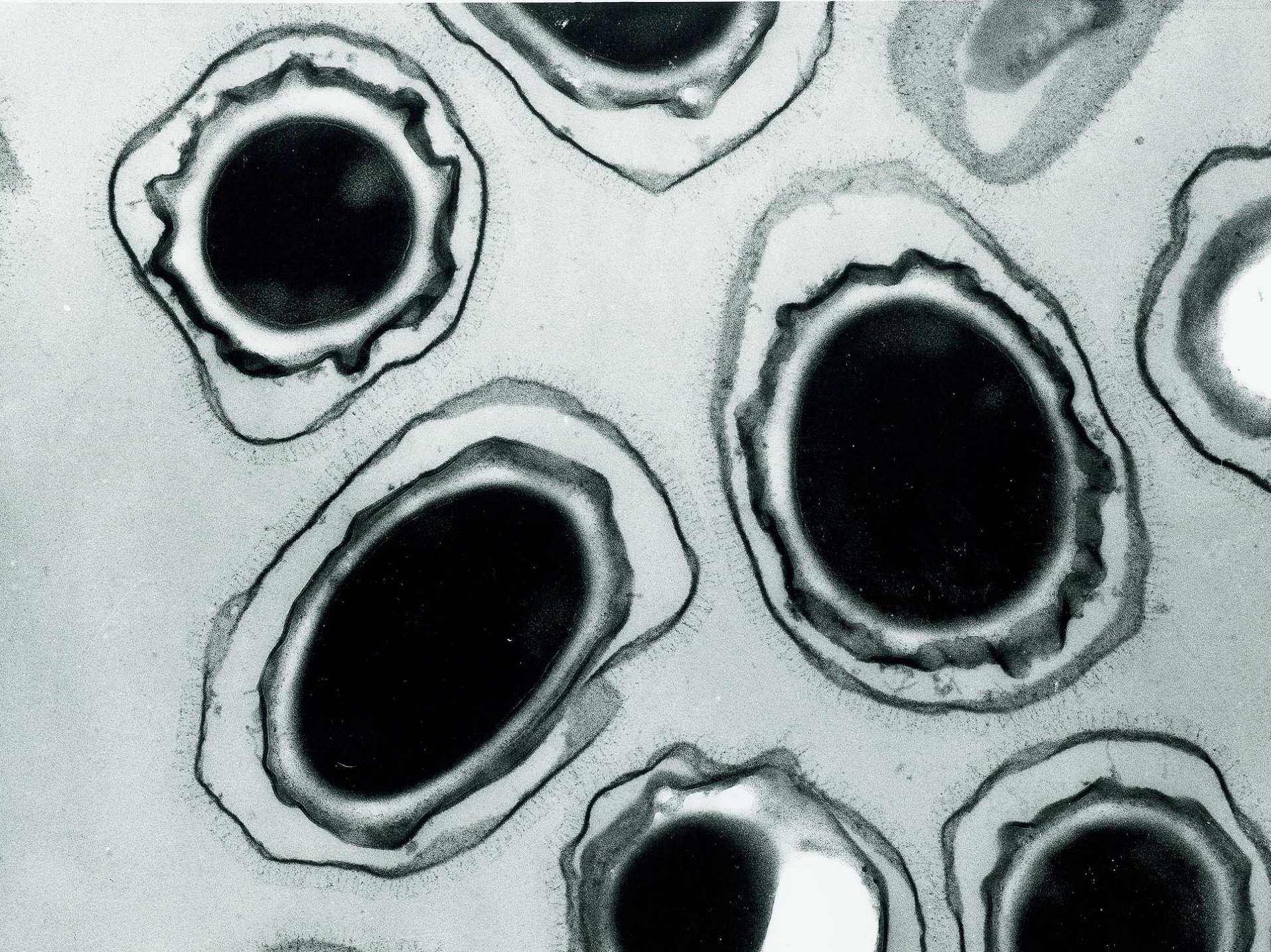
Profile **K**

Comparison

Match Criteria

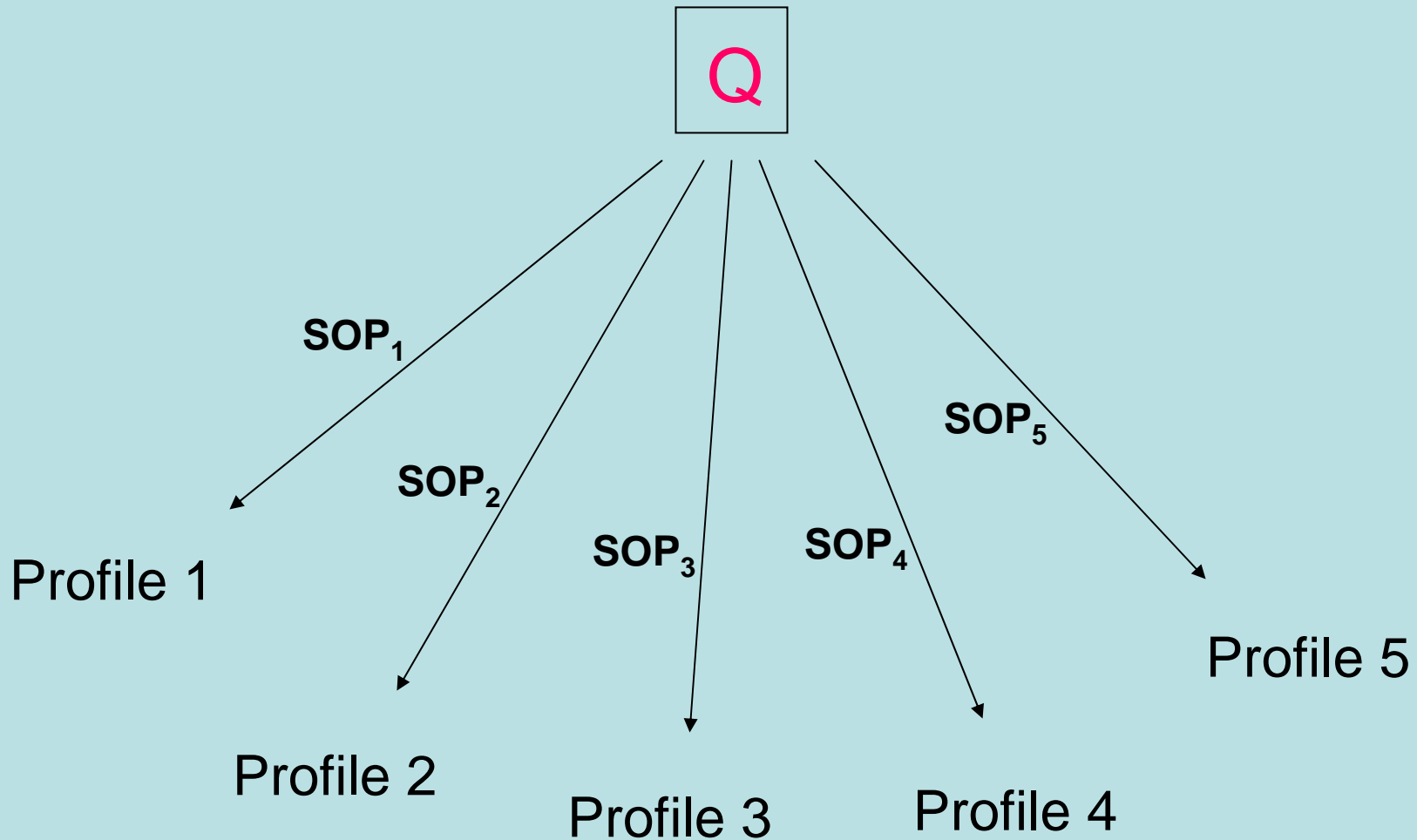
Conclusion

- Match → Weight Assessment
- Exclusion
- Inconclusive





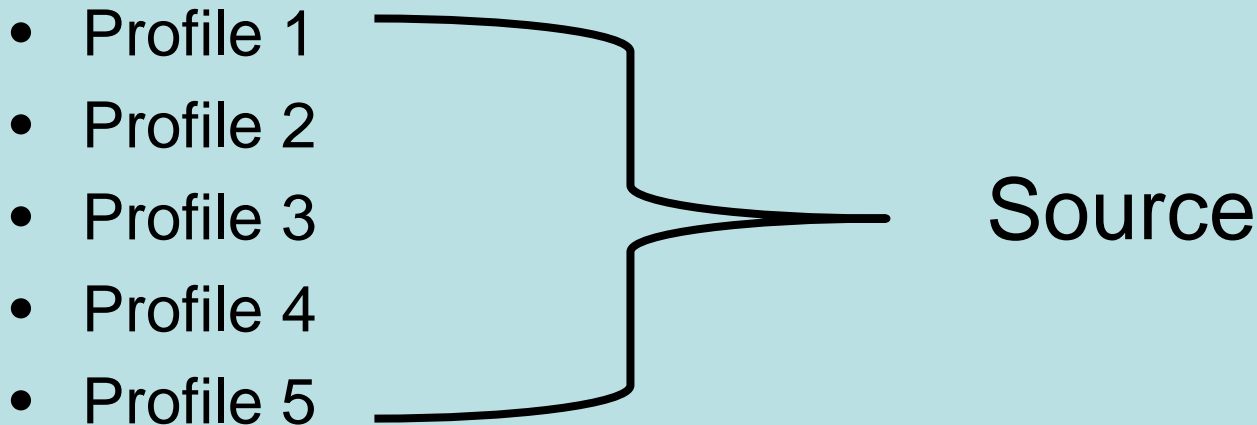
Terrorism Investigation Forensic Typing – No Known Samples!





Challenge

- Question: Can the characteristics of the questioned sample lead us to identify the source of the material?
- Answer: Not without extensive, pre-event data on all of the characteristics of each potential agent at our fingertips.





Forensic Questions



- What is the agent?
 - Species, strain, sub-strain, or more
- Was the event intentional?
 - Obvious in the Anthrax case
 - Difficult with food-borne illnesses
- Was the pathogen engineered?
 - Did it come from a biowarfare program, or is it common in nature, a lab...
 - Requires detailed knowledge of natural variation
- Where did it come from?
- How / When was it made?
- Who did it - attribution?



Magnitude of the Challenge



- **Any infectious agent can be used as a biological weapon**
- **Emerging pathogens**
- **Over 1000 agents known to infect humans***
 - 217 virus species
 - 538 bacterial species
 - 307 fungi
 - 66 parasitic protozoa
- **Approximately 50,000 plant pathogens identified.**
- **Numerous strain variations**
- **Potential bio-engineered organisms**

**Taylor et al, Phil. Trans. R. Soc. Lond. B (2001) 356, 983-989*



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Opportunities to Intersect Disciplines Towards Deep Knowledge, Adaptive Capabilities



Epidemiology

Genomics

Informatics

*Biostatistics &
Population
Genetics*

Forensic Science

*Microbiology,
Virology &
Mycology*

Microbial Forensics

Plant Pathology

*Biomedical Sciences
& Public Health*

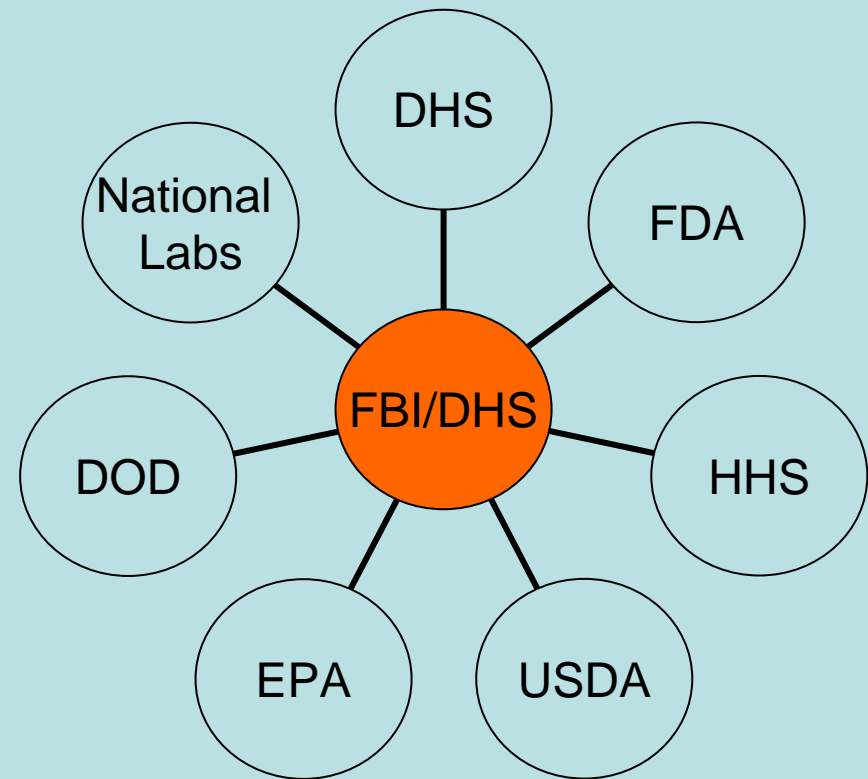
Ecology

*Analytical Chemistry &
Biochemistry*

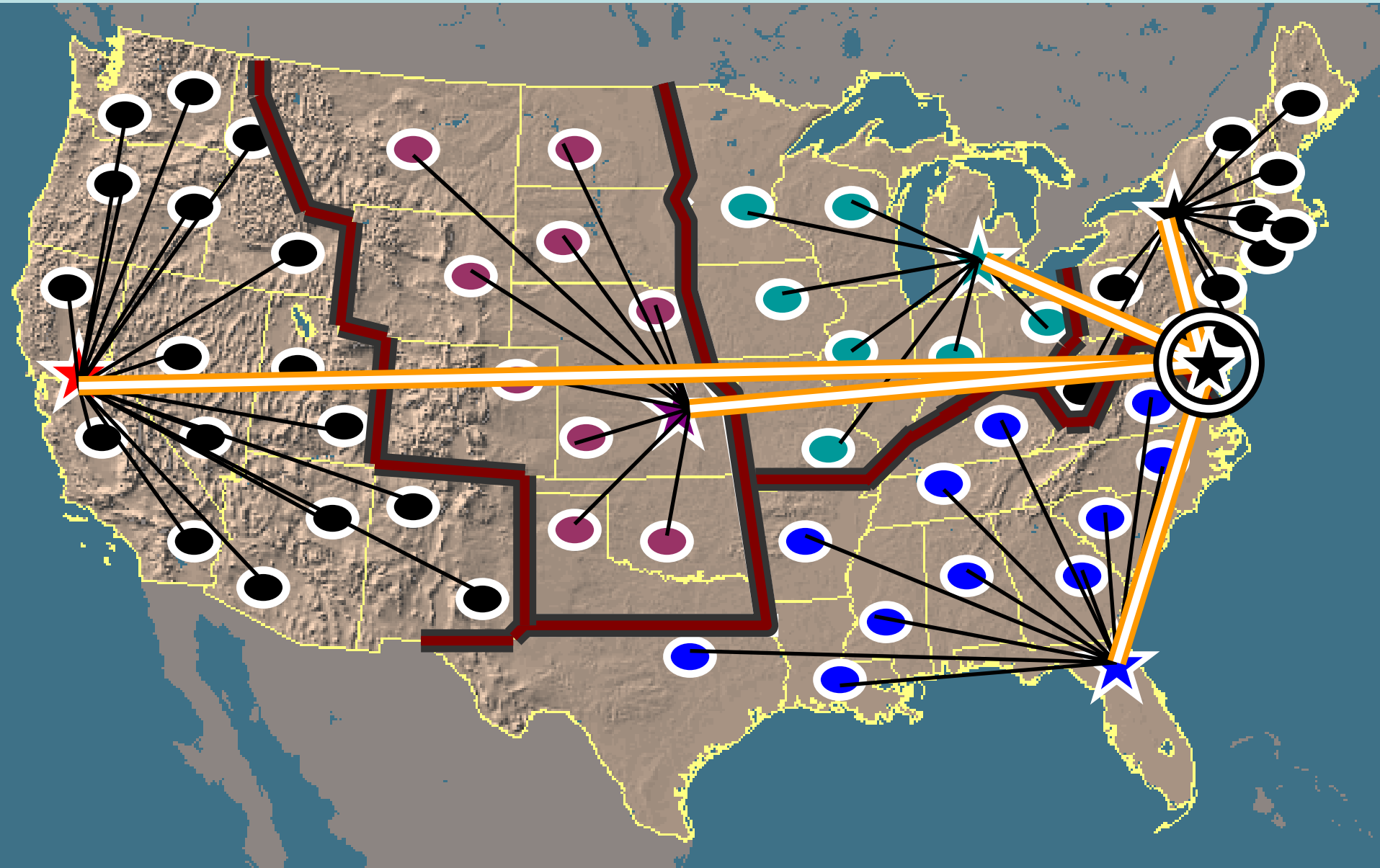
*Veterinary
Medicine*

The Solution: Success Through Partnerships

- Establish dedicated forensic CBRN facilities.
 - Coordination with Dept. of Homeland Security.
 - **Hub** and Spoke Network
 - Supported by Interagency Working Groups: set priorities, establish guidelines, assess infrastructure



USDA: National Plant Diagnostic Network





National BioForensic Analysis and Countermeasures Center (NBFAC)



- **NBFAC IS** “the lead Federal facility to conduct and facilitate the technical forensic analysis and interpretation of materials recovered following a biological attack in support of the appropriate lead Federal agency.”
Presidential Directive, Biodefense for the 21st Century, April 2004
- **NBFAC WILL** provide a national capability to conduct forensic analysis of evidence from biocrimes and bioterrorism to attain a “biological fingerprint” providing data to identify perpetrators and determine the origin and method of attack.



NBFAC Objectives



- Establish dedicated containment laboratories and spoke laboratories to conduct bioforensic analyses.
- Conduct and coordinate bioforensic research and casework.
- Evaluate, validate, and establish assays for high consequence biological threat agents.
- Establish an internationally recognized accreditation program for bioforensic casework.
- Establish bioforensic reference collections for comparative identification.



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Much to do!

- Need for meaningful signatures: genomics, proteomics, bioinformatics, chemistry, etc.
- Need better understanding of pathogens.
- Need better understanding of matrices and environmental effects.
- Need appropriate and dedicated facilities to support analyses.



Much to do! (cont.)

- Need validation centers : Rapidly move S&T from the academic domain to the forensic domain.
- Need a knowledge management system: Collation of existing knowledge.
- Must have methods for traditional forensic examinations of contaminated evidence.
- Defined analytical plans based on a thorough review of the “possibilities”.



Threat Analysis

- Differentiating "Natural" from Deliberate Introduction
 - Were there any threats – were they credible?
 - Did the event - appear suspicious?
 - Occur at unusual location, have unusual timing?
 - e.g., during political, terrorist or military tension?
 - Did disease appear at multiple simultaneous locations?
 - Was there more than one type of agent?
 - Was there disease outside expected animal or plant transportation routes?
 - Was the introduction predicted?
 - Was the emergence consistent with epidemiological modeling?
 - Was the type of disease or agent unusual?
 - Were there unique characteristics or properties?
 - Was there a significant and unexpected setback in disease control?
 - Was there economic or political loss - or benefit to a criminal element. competitor or adversary?



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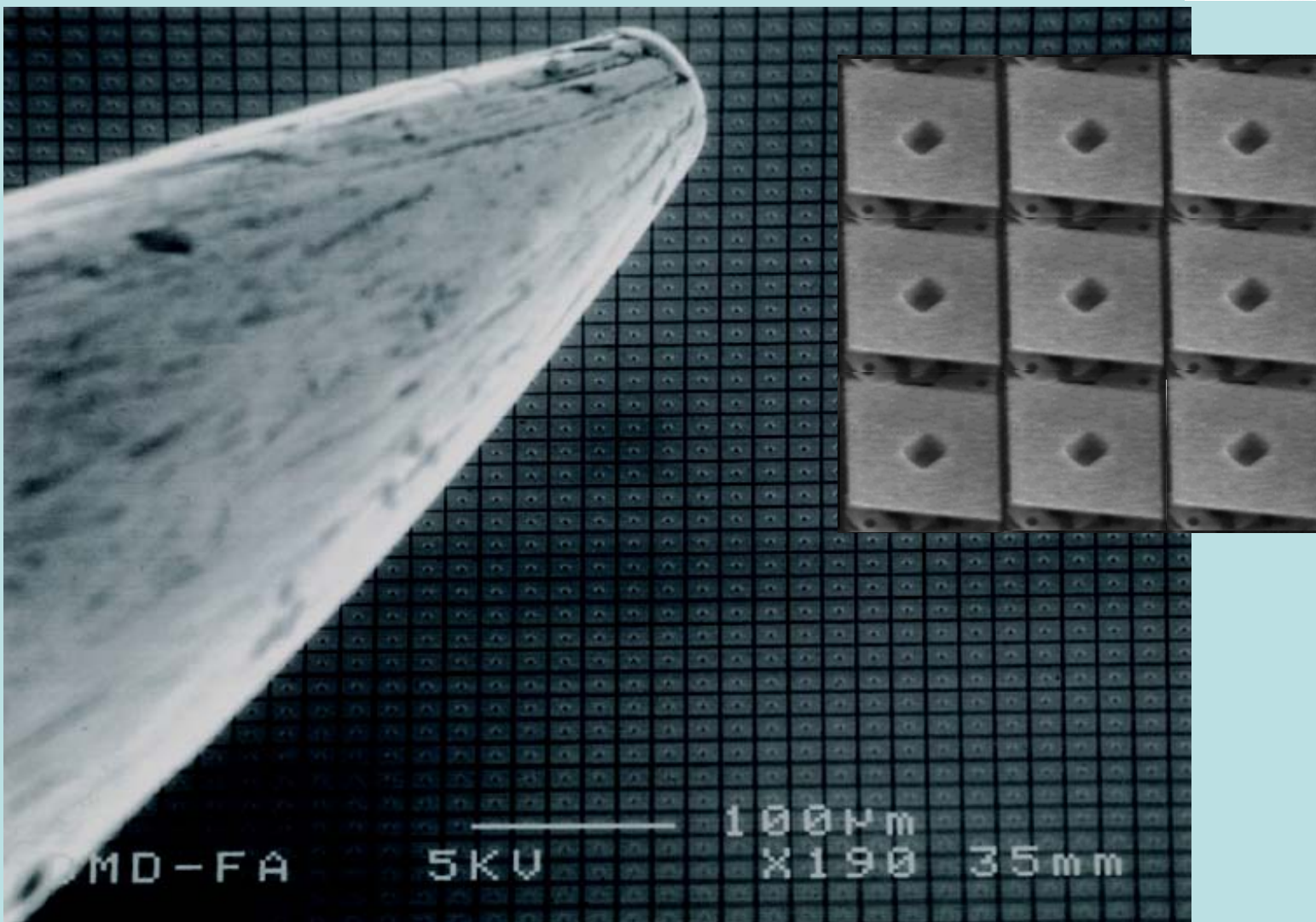


New Technologies – Speeding the Process of Genetic Characterization

- Whole Genome Amplification
 - Non-specific amplification of all DNA present in a sample – single cell detection sensitivity.
- Microarray analysis
 - Flexibility in design and manufacture has greatly decreased the cost of this technology.

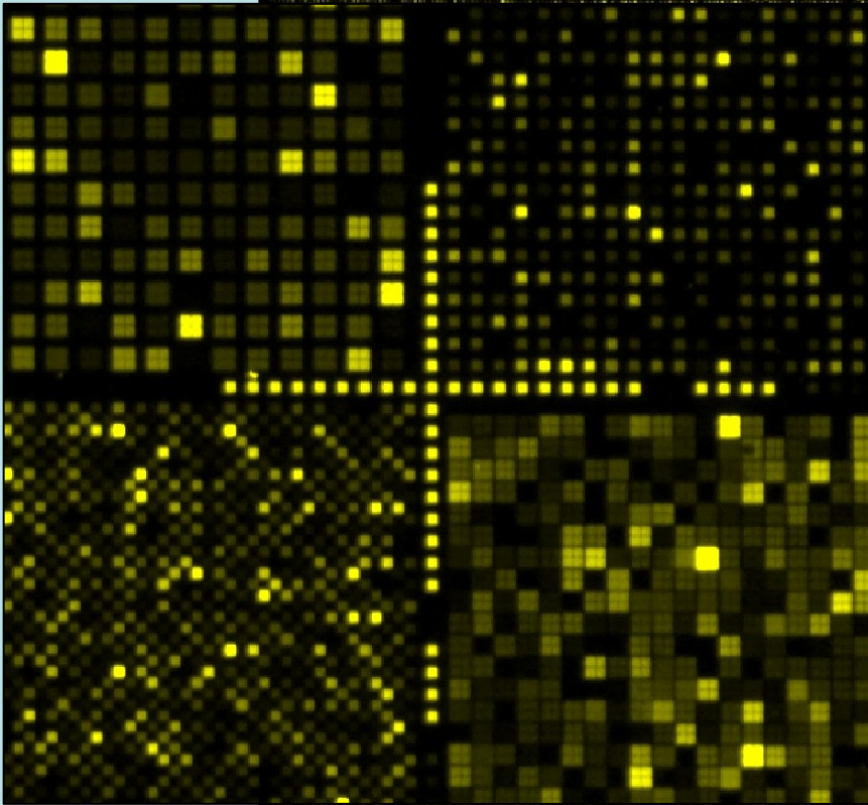


DMD: Digital Micromirror Device

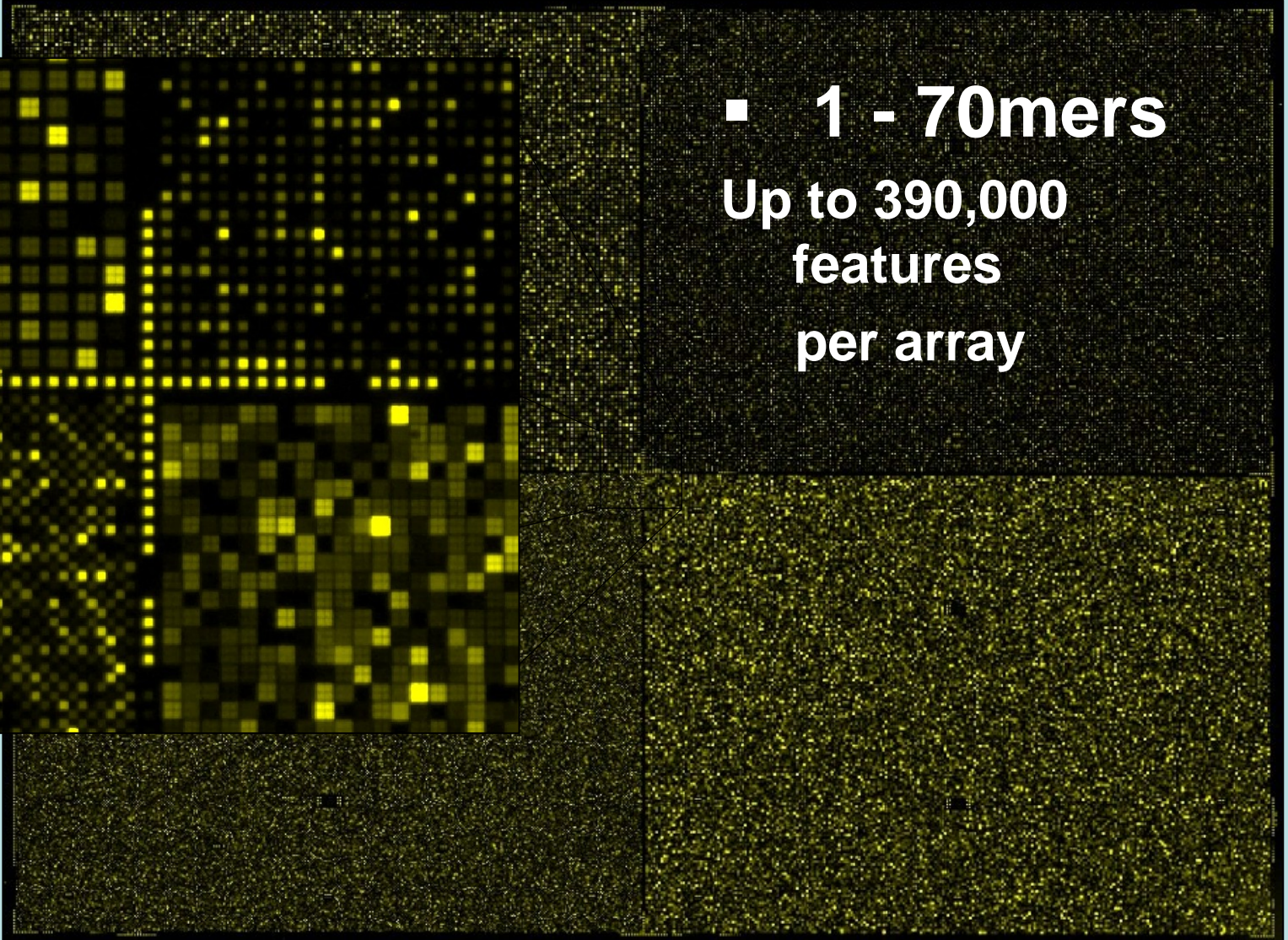




New Array Options



- **1 - 70mers**
Up to 390,000
features
per array





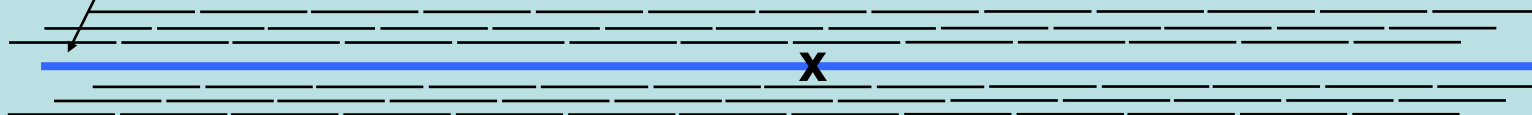
Comparative Genomic Hybridization



Reference Genome



Test Genome





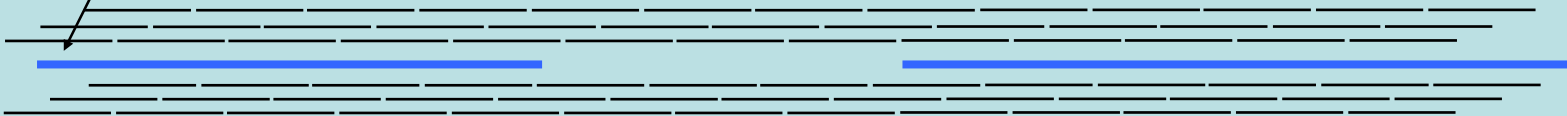
Comparative Genomic Hybridization



Reference Genome



Test Genome





Summary

- Quality assurance practices are necessary for legal admissibility.
- Magnitude of the problem necessitates full collaboration and coordination between academia, government, and private industry.
- Risk to agriculture requires new analytical approaches.
- New technologies must be thoroughly assessed and integrated if we are to meet the challenge ahead.



The End

Thank you!