Adapting Cybersecurity Practice to Reduce Wildlife Cybercrime

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Me

Following my 34 years at the Lubar College of Business, University of Wisconsin-Milwaukee, I am now the director of my *Profitable Biodiversity* consultancy.

My consultancy helps private enterprise create profitable offerings whose sale indirectly benefits biodiversity.

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Biodiversity is Going Away

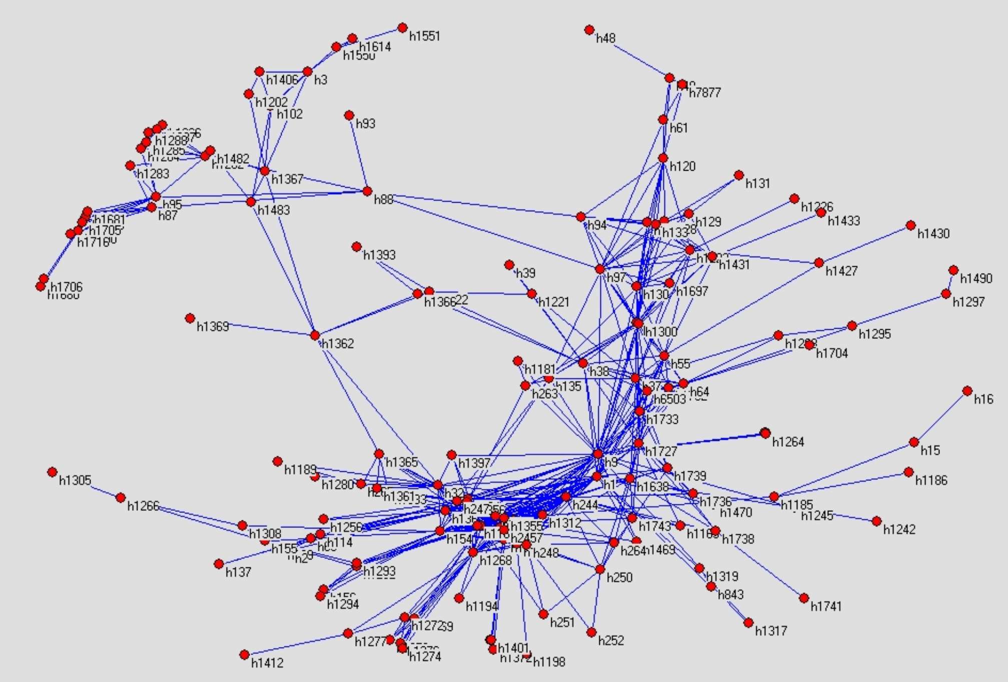
- The sixth mass extinction in the history of the planet is underway.
- Most large, wild mammals, many fish species, and many rare plants will be gone by 2060.
- Current conservation strategies are not working.

Cycads, Sharks, and Elephants

- For instance, the cycad plant, poached as a status symbol and investment, has been on this planet for about 280 million years. Dinosaurs didn't show up until 245 million years ago.
- The great white shark, a particular species of fish is endangered.
- And the African savanna elephant was added to the IUCN Red List in 2021.

Curbing These Human-Driven Extinctions

- The wholesale killing of animals and plants needs to stop, and habitat destruction needs to be curtailed.
- Recently, wildlife crime has become the most destructive force driving species extinctions – surpassing habitat destruction for the first time.



South African rhino poaching network as of December 2014.

An Actionable Intelligence Report

```
---- 1. Centrality Measures ----
Player    Eigenvector                     Predicted Group
  h240         0.162                        middlemen
    h9         0.158                        middlemen
Player    Degree
    h9        75.000                        middlemen
  h240        61.000                        middlemen
Player    Betweenness
    h9     37516.993                        middlemen
   h97     25403.954                        middlemen
Player    Gould-Fernandez Total Brokerage
    h9      1889.0                          middlemen
  h240       960.0                          middlemen

 ---- 2. Optimal Arrest Sequence: h240 and then h9

 ---- 3. Successor Prediction(s): h1727 will succeed h240.
                                  h134 will succeed h9.

 ---- 4. Influential Player Attempting to Hide ----
         (highest ratio of betweenness centrality to degree centrality): h3

 ---- 5. Rising Stars ----
   Need 2 or more time points to predict rising stars.

 ---- 6. Recovery Time -----
   Need 2 or more time points to compute network resiliency index.
```

Confederation Actions

1. *Detain list*: A list of those players that law enforcement should detain for maximal disruption effect.
2. *Surveil list*: A list of those players that should be placed under surveillance for purposes of gathering evidence and/or information on pending wildlife crime activities.
3. *Interdict list:* A list of predicted WTS actions along with where and when these actions will take place. These actions should be interdicted.
4. *Recovery time:* An estimate of how long the WTS will take to recover from the removal of those players in the Detain list. Use this information to plan detention, surveillance, and interdiction operations.

The Logistics Office has Minimal Activities

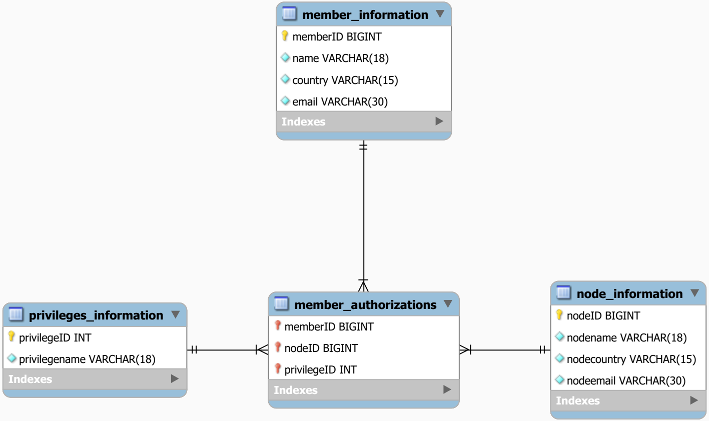
1. Support member-to-member communications.
2. Maintain the *logistics node* of the confederation's database and its access control tool.
3. Process membership applications and associated security auditor reports.
4. Prepare the confederation's budget and bill members for dues.

This is *rule-based management* among peers.

The Logistics Node Holds Only Administrative Data

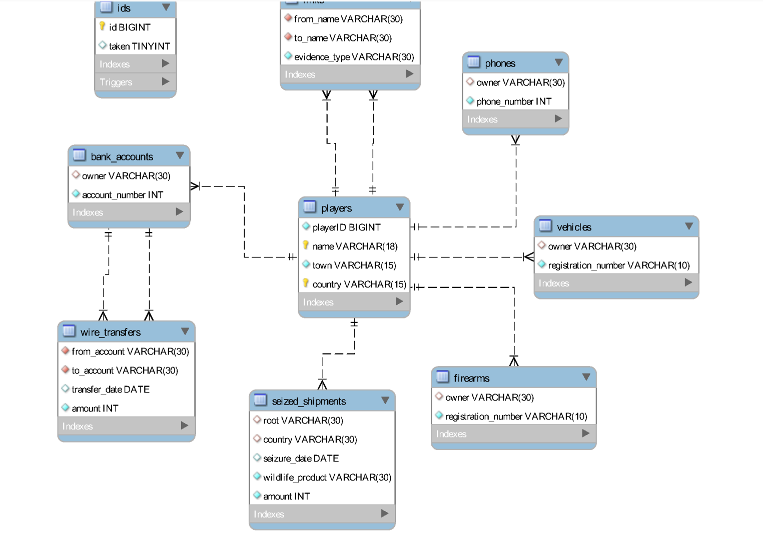
1. Member contact information.
2. Each member's corruption index value and information technology (IT) security index value.
3. Contact information for the corruption auditor and the IT security auditor.
4. The confederation's budget.
5. EMT software, including all database software.

The Logistics Node’s Database is Small



In this *entity relationship diagram*, a double bar into an entity indicates a source entity can map to only one entity whereas a trident indicates a source entity can map to many entities.

Confederation Database Tables



ids
- id BIGINT
- taken TINYINT
- Indexes
- Triggers

- from_name VARCHAR(30)
- to_name VARCHAR(30)
- evidence_type VARCHAR(30)
- Indexes

phones
- owner VARCHAR(30)
- phone_number INT
- Indexes

bank_accounts
- owner VARCHAR(30)
- account_number INT
- Indexes

players
- playerID BIGINT
- name VARCHAR(18)
- town VARCHAR(15)
- country VARCHAR(15)
- Indexes

vehicles
- owner VARCHAR(30)
- registration_number VARCHAR(10)
- Indexes

wire_transfers
- from_account VARCHAR(30)
- to_account VARCHAR(30)
- transfer_date DATE
- amount INT
- Indexes

seized_shipments
- root VARCHAR(30)
- country VARCHAR(30)
- seizure_date DATE
- wildlife_product VARCHAR(30)
- amount INT
- Indexes

firearms
- owner VARCHAR(30)
- registration_number VARCHAR(10)
- Indexes

The GLAD Access Control Tool

- This tool automates the task of deciding who may access what in a federated database and enforces all restrictions imposed by nodes for access to their local databases that, collectively, make up the confederation database.
- The tool consists of the following three modules.

GLAD Access Control Tool Modules

1. *Local Security:* Specifies the local authorization policy of each node.
2. *Global Security:* Runs algorithms to combine all exported local authorizations into global ones.
3. *Dictionary:* Executes operations on nodes as per requests from (access-controlled) confederation members.

GLAD Access Control can be Conservative

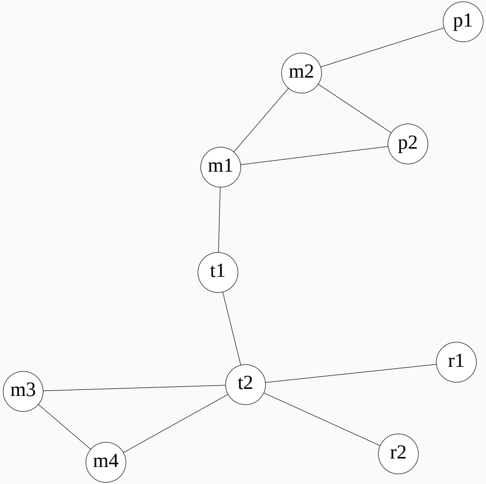
The GLAD access control tool can be configured to implement a *strictly conservative* access authorization strategy that ensures global authorizations derived from exported local authorizations do not result in a member being given global access privileges that exceed the lowest level of privileges given to that member across all nodes.

Confederation Database Scripts

Script	Purpose
Local Security module	
1. `create_node.sql`	Create a database node.
2. *`required_changes.sql`	Change the privileges of one or more members as dictated by a single node.
Global Security module	
3. `create_logistics.sql`	Create the logistics node database.
4. `update_glad.ps1`	Manage an update of GLAD authorizations.
5. *`compute_glad.sql`	Compute GLAD authorizations.
6. *`update_privileges.sql`	Create an SQL script to update privileges.
7. `global_privileges.sql`	Update a node's GLAD authorizations.
8. *`update_email.ps1`	Send an email to a node directing it to run the attached `global_privileges.sql`.
Dictionary module	
9. `fedquery.ps1`	Run a query against the database.
10. `example_query.sql`	An example query.

*script is executed within `update_glad.ps1`.

A Hypothetical WTS



Poacher names: “p*;” middlemen: “m*;” traders: “t*;” and retailers: “r*.”

Centrality Measures of the WTS

Player	Eigenvector	Betweeness	Degree	Betweenness / Degree
t2	0.552	68	5	13.6
m4	0.361	18	2	9.0
m3	0.361	18	2	9.0
t1	0.352	58	2	29.0
m1	0.300	54	3	18.0
m2	0.244	34	3	11.3
r2	0.228	18	1	18.0
r1	0.228	18	1	18.0
p2	0.216	18	2	9.0
r1	0.092	18	1	18.0

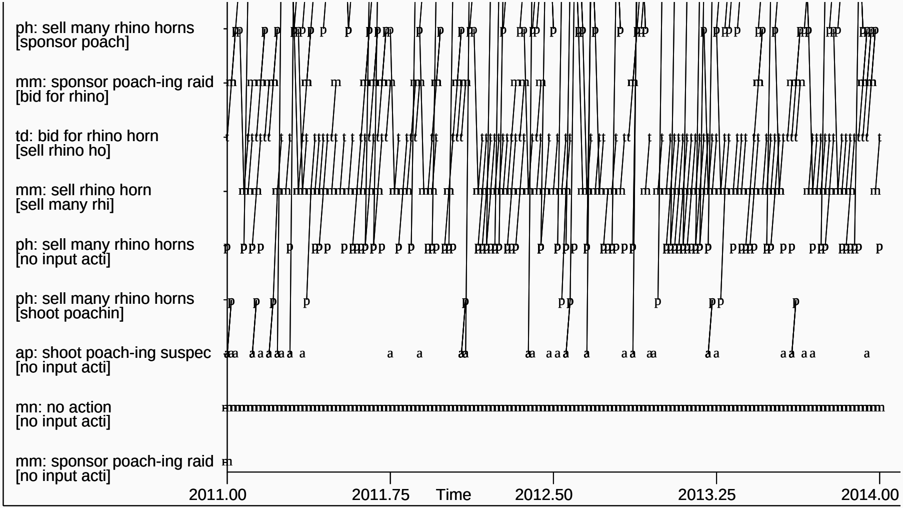
Intelligence Gathered on Player Attributes

Internal identifier	Player name	Town	Country	Number of vehicles	Vehicles
h1	r1	A	Y	0	
h2	m3	B	Y	0	
h3	m4	A	Y	0	
h4	r2	A	Y	0	
h5	t2	B	Y	0	
h6	t1	A	Y	1	lu7
h7	p2	D	Z	0	
h8	m1	D	Z	0	
h9	m2	E	Z	0	
h10	p1	D	Z	0	
h11	t11	C	Z	1	lu7

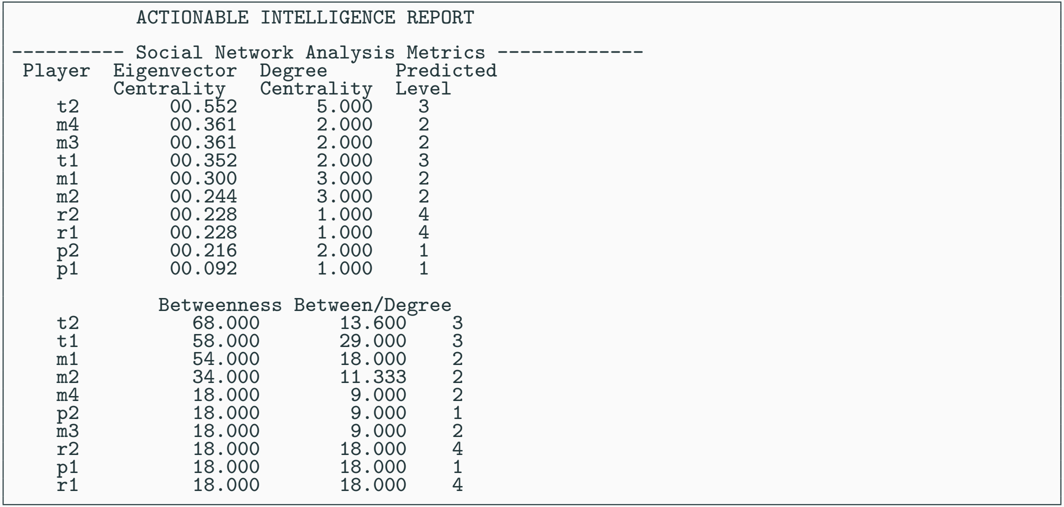
Player-to-Player Interactions Intelligence

Player 1	Player 2	Interaction type
p1	m2	call
m2	p2	call
m2	m1	shipment
p2	m1	shipment
t1	m1	transfer
t2	t1	call
t2	r2	call
t2	r1	call
t2	m3	call
t2	m4	call
m3	m4	call
t11	m1	call
t11	r1	transfer

Fitted Simulator’s Actions History



Actionable Intelligence Report



```
           ACTIONABLE INTELLIGENCE REPORT

---------- Social Network Analysis Metrics -------------
 Player  Eigenvector  Degree      Predicted
         Centrality   Centrality  Level
    t2        00.552       5.000    3
    m4        00.361       2.000    2
    m3        00.361       2.000    2
    t1        00.352       2.000    3
    m1        00.300       3.000    2
    m2        00.244       3.000    2
    r2        00.228       1.000    4
    r1        00.228       1.000    4
    p2        00.216       2.000    1
    p1        00.092       1.000    1

             Betweenness Between/Degree
    t2          68.000       13.600    3
    t1          58.000       29.000    3
    m1          54.000       18.000    2
    m2          34.000       11.333    2
    m4          18.000        9.000    2
    p2          18.000        9.000    1
    m3          18.000        9.000    2
    r2          18.000       18.000    4
    p1          18.000       18.000    1
    r1          18.000       18.000    4
```

Potential Information Brockers

```
           Gould-Fernandez
           total brokerage
    t2          9.0        3
    m1          2.0        2
    m2          2.0        2
    t1          1.0        3
    m4          0.0        2
    p2          0.0        1
    m3          0.0        2
    r2          0.0        4
    p1          0.0        1
    r1          0.0        4

 ------------------ Detain list ------------------
SNA sublist.
Optimal Arrest Sequence:
t2 is the first player to arrest and t1 is the second player to arrest.

Ecosystem effects sublist.
players t1, p2, m1
```

Surveil List and WTS Communities

```
-------------------- Surveil list ---------------------
Successor Prediction(s):
r2 will succeed t2.
m1 will succeed t1

Influential Player Attempting to Hide (highest ratio of betweenness
centrality to degree centrality): t1

Rising Stars: Need 2 or more time points to predict rising stars.

Community Structure.
Number of communities: 2

 Player    Community
    r1        5
    m3        5
    m4        5
    r2        5
    t2        5
    t1        5
    p2        8
    m1        8
    m2        8
    p1        8
```

WTS Actions to Interdict

```
----------------- Interdict list -------------------
January 2016: m3 will sell rhino horns in town B, country Y

------ Network Resiliency Index (Recovery time) --------
Current network's connectivity index value:   2.592
   Need 2 or more time points to compute network resiliency
   index.
```

Access Control Update Dictated by Node 2

```
************** User privileges granted at database creation *********
GRANT SELECT, INSERT, DELETE ON *.* TO ‘Jay Lee‘@‘%‘
GRANT SELECT, INSERT, DELETE ON *.* TO ‘Jeff Lee‘@‘%‘
GRANT SELECT, INSERT, DELETE ON *.* TO ‘John Doe‘@‘%‘

************** update_glad.ps1: Running required_changes.sql ********
delete from member_authorizations where memberID = 51 and nodeID = 2

insert into member_authorizations
   (memberID, nodeID, privilegeID) values (51, 2, 1)

************** update_glad.ps1: Running compute_glad.sql ************
set @nmnodes = (select count(nodeID) from node_information)

delete from member_authorizations where nodeID = 0
```

Access Control Update Continued

```
create temporary table n (
   memberID bigint unsigned not null default 0,
   privilegeID int unsigned not null default 0,
   nmgivenpriv int unsigned not null default 0,
   nodeID int unsigned not null default 0)

insert into n (memberID, privilegeID, nmgivenpriv)
   select memberID, privilegeID, count(*) as nmgivenpriv
   from member_authorizations
   group by memberID, privilegeID
   having nmgivenpriv = @nmnodes

delete from n where memberID = 0
update n set nodeID = 0
set foreign_key_checks=0
insert into member_authorizations (memberID, nodeID, privilegeID)
   select memberID, nodeID, privilegeID from n
```

Updated Authorizations for Confederation Members

```
select * from member_authorizations

1    0   1
1    1   1
1    2   1
9    0   1
9    1   1
9    2   1
51   0   1
51   1   1
51   2   1
1    0   2
1    1   2
1    2   2
51   1   2
```

SQL Script Emailed to Every Node

```
************** update_glad.ps1: Running update_privileges.sql *******
************** global_privileges.sql ********************************
grant select  on *.* to ’Jay Lee’;
revoke all on *.* from ’Jay Lee’;

grant select  on *.* to ’Jeff Lee’;
revoke all on *.* from ’Jeff Lee’;

grant select  on *.* to ’John Doe’;
revoke all on *.* from ’John Doe’;
flush privileges;

grant select on *.* to ’John Doe’;
show grants for ’John Doe’;
GRANT SELECT ON *.* TO ‘John Doe‘@‘%‘;

grant select on *.* to ’Jeff Lee’;
show grants for ’Jeff Lee’;
GRANT SELECT ON *.* TO ‘Jeff Lee‘@‘%‘;

grant select on *.* to ’Jay Lee’;
show grants for ’Jay Lee’;
GRANT SELECT ON *.* TO ‘Jay Lee‘@‘%‘;
grant insert on *.* to ’Jay Lee’;
show grants for ’Jay Lee’;
GRANT SELECT, INSERT ON *.* TO ‘Jay Lee‘@‘%‘;
flush privileges;

************** update_glad.ps1: Running update_email.ps1 ************
(output not shown)
```

Trace of the Query Attempted by the Untrusted Member

```
******** example_query.sql: run on node #2 *************
use node2;
insert into phones (owner, phone_number)
   values('m3', 123456789);

******** example_query.sql: output *********************
ERROR 1142 (42000) at line 8: INSERT command denied to user
'John Doe'@'localhost' for table 'phones'
```