Discovery of a Large Sexual Network Using Routine Partner Services Data, San Francisco, 2013

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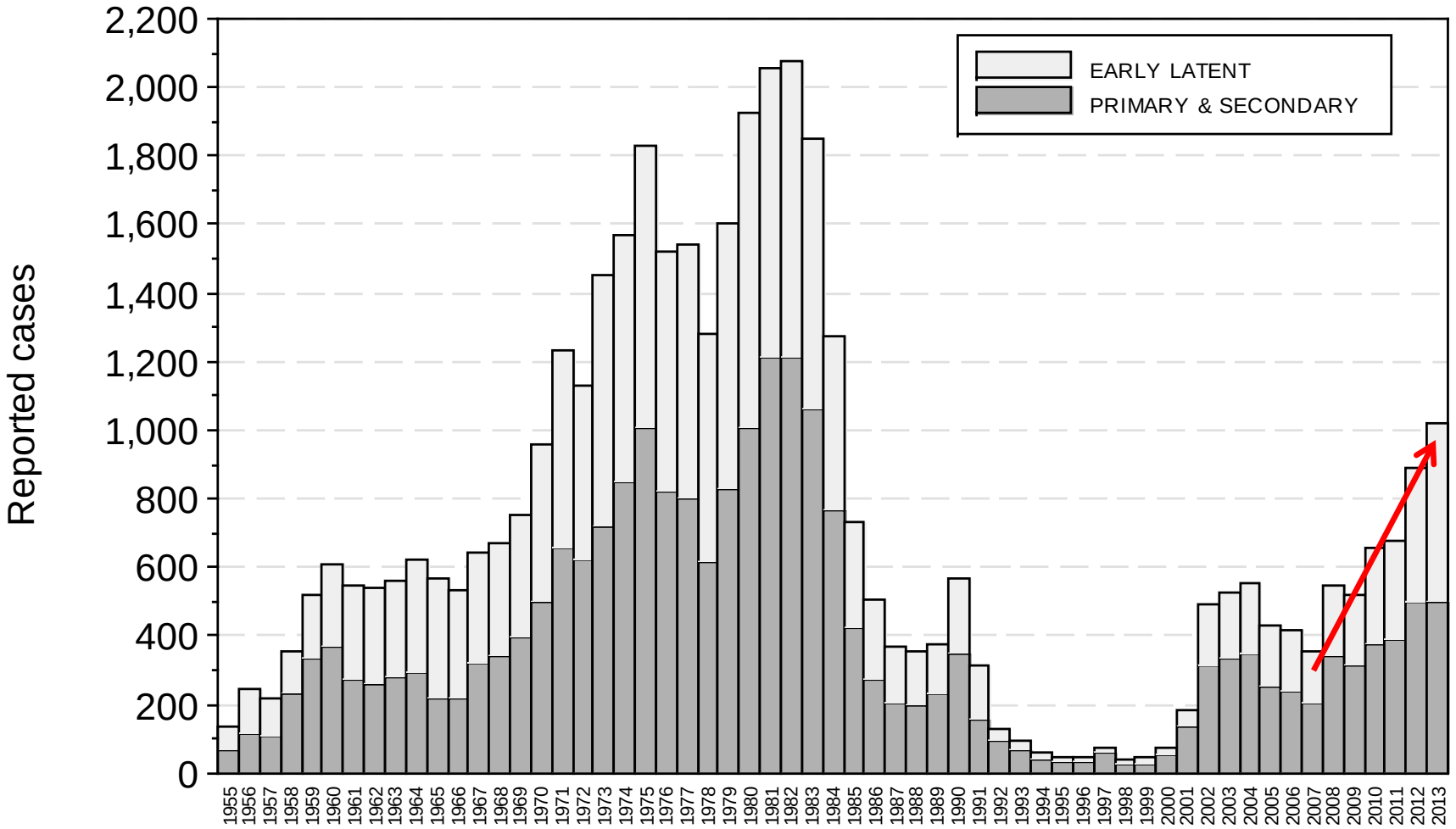
City Clinic
A landmark in prevention

Background

- Defining the network of partners to cases defines the only population really at risk for STD
- People in same “social” network as cases are also at risk because of other partners that their own partners may have in common.
- STD epidemics are sustained by sexual activity concentrated in a relatively small "core" of persons in the community
- Effective STD control efforts must identify and treat "core" transmitters
  - Geography of cases
  - Partner services data?

Syphilis in San Francisco, 1955 through 2013



Partner notification in San Francisco

- Syphilis cases
- New HIV infections
- Standard CDC protocols
  - Critical period
  - Elicit names of partners
- Internet partner services

Data management

- All STD data in single database (“ISCHTR”)
  - Patient-based registry
  - Surveillance, screening, partner notification, STD clinic medical record data
  - Partners and cases handled the same way
  - Patients may be identified just by email or profile name
- Chains and networks of individuals

```
-- find all partners
select *
into #one
from tblpartner
where year(initdate) in (2013)
and refbasis in ('P1', 'P4', 'S2', 'A2')

-- make file of all partnerships for each client
select distinct a1.id as client_id, a2.id as sexpartner_id
into #two
from #one as pn
inner join tblasgn as a1 on a1.asgnno = pn.asgnno
inner join tblinterview as ix on ix.casenum = pn.casenum
inner join tblasgn as a2 on a2.asgnno = ix.asgnno
union
select distinct a2.id as client_id, a1.id as sexpartner_id
from #one as pn
inner join tblasgn as a1 on a1.asgnno = pn.asgnno
inner join tblinterview as ix on ix.casenum = pn.casenum
inner join tblasgn as a2 on a2.asgnno = ix.asgnno

-- make file of network for each client (start as missing)
select distinct client_id, cast(null as int) as network
into #three
from #two

declare @indexid int
declare @networkid int

-- find client not in a network
select @indexid = min(client_id)
from #three
where network is null
while @indexid is not null
begin

    -- put client in his own network

    select @networkid = (select isnull(max(network), 0) from #three) + 1

    update #three
    set network = @networkid
    where client_id = @indexid

    -- find partners not already in his network

    while exists (
        select *
        from #two
        inner join (
            select client_id from #three where network = @networkid
        ) as x on x.client_id = #two.client_id
        left outer join (
            select client_id from #three where network = @networkid
        ) as y on y.client_id = #two.sexpartner_id
        where y.client_id is null
    )
    begin
        -- add partners to the network
        update #three
        set network = @networkid
        from #three as x
        inner join (
            select #two.*
            from #two
            inner join (
                select client_id from #three where network = @networkid
            ) as x on x.client_id = #two.client_id
            left outer join (
                select client_id from #three where network = @networkid
            ) as y on y.client_id = #two.sexpartner_id
            where y.client_id is null
        ) as z
            on z.sexpartner_id = x.client_id
    end

    select @indexid = min(client_id)
    from #three
    where network is null
end
```

Network algorithm

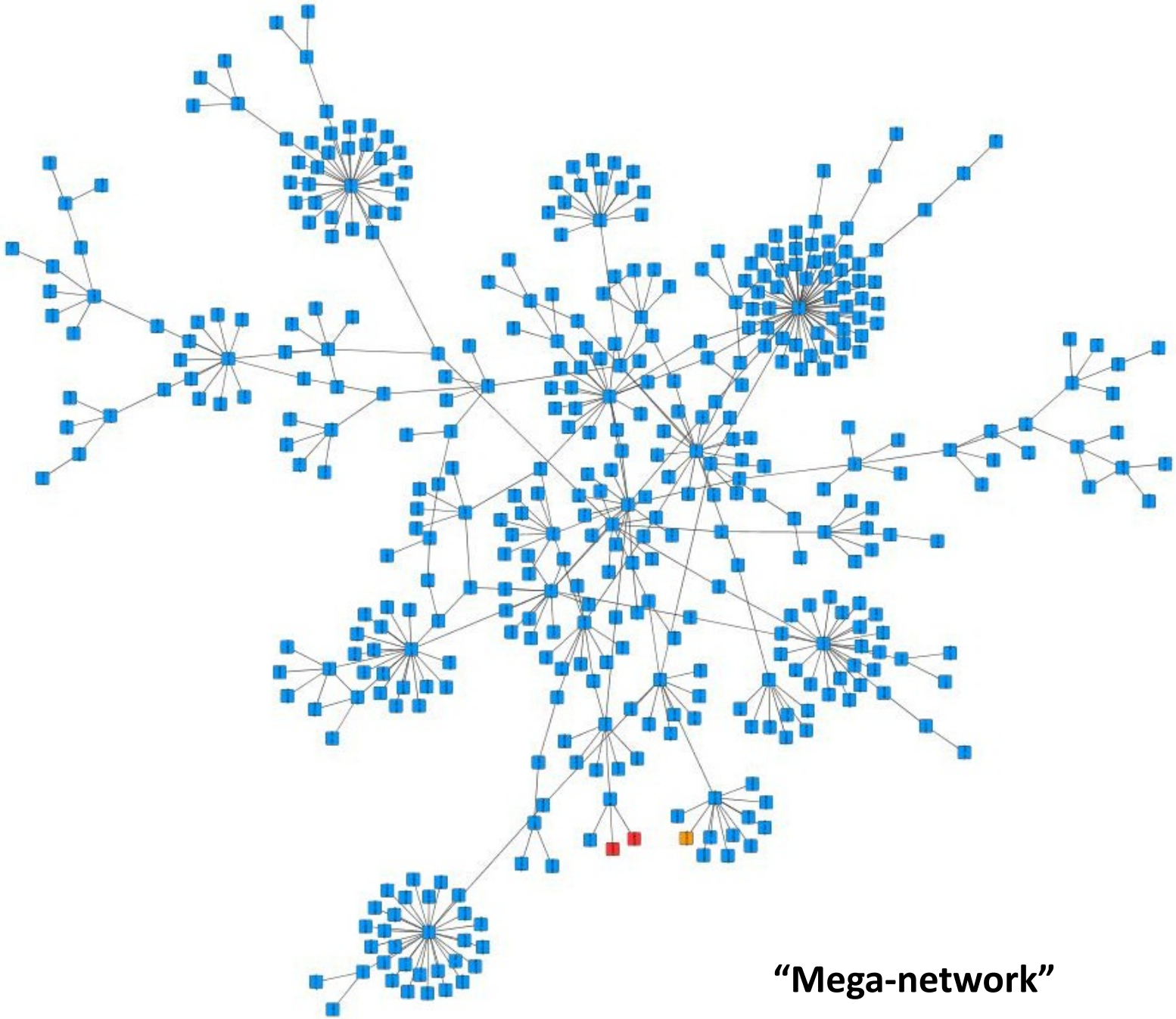
- Find all the named partnerships in the time period
- Make an unduplicated list of individuals
- Put the first individuals into network #1
- Find all his partners, put them into same network
- Find all of *their* partners; if any are not already in the network, add them to the network as well
- Repeat until no partners are found who are not already in the network
- Find an individual who was not in that first network, put him in network #2, and find his partners
- Repeat until all individuals are in some network

Partner notification data, 2013

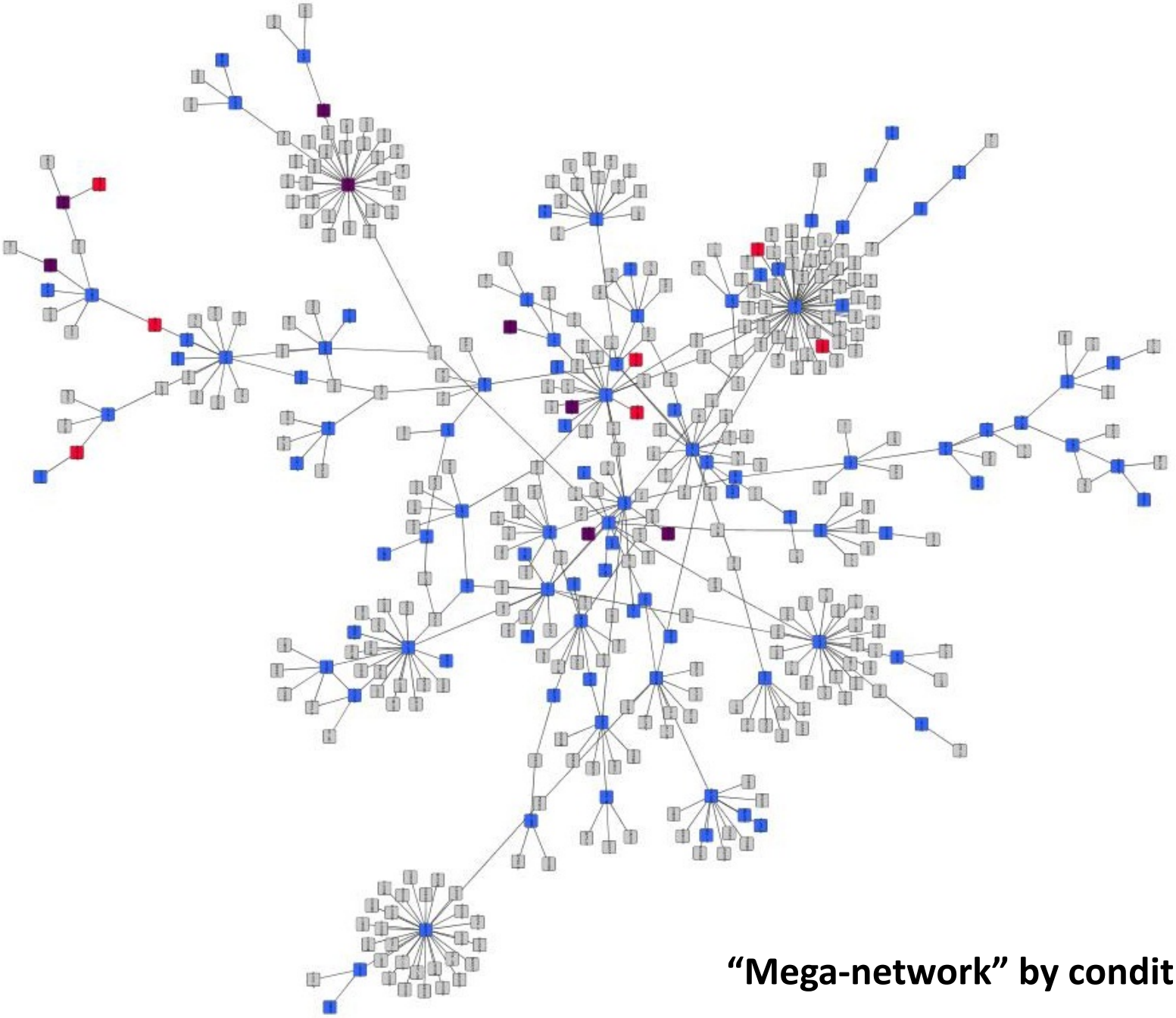
- Partnerships identified in 2013
- Both syphilis and HIV cases
- 1332 individuals
- 1066 sexual partnerships

Results

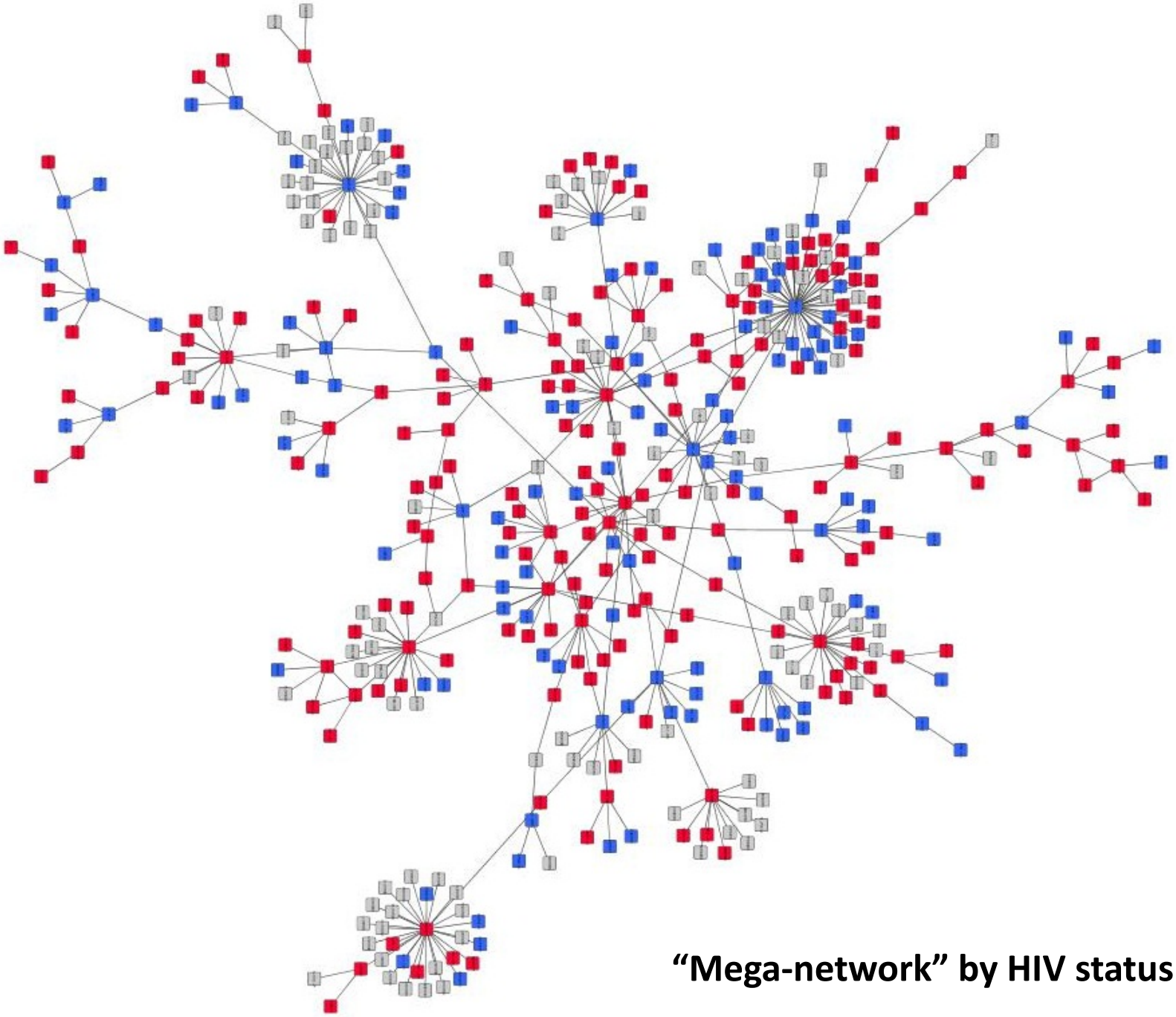
Size of network	*Number of networks*
2	182
3	47
4	15
5	18
6	6
7	4
8	1
9	2
10	3
11	1
13	2
18	1
19	1
21	1
27	1
435	1



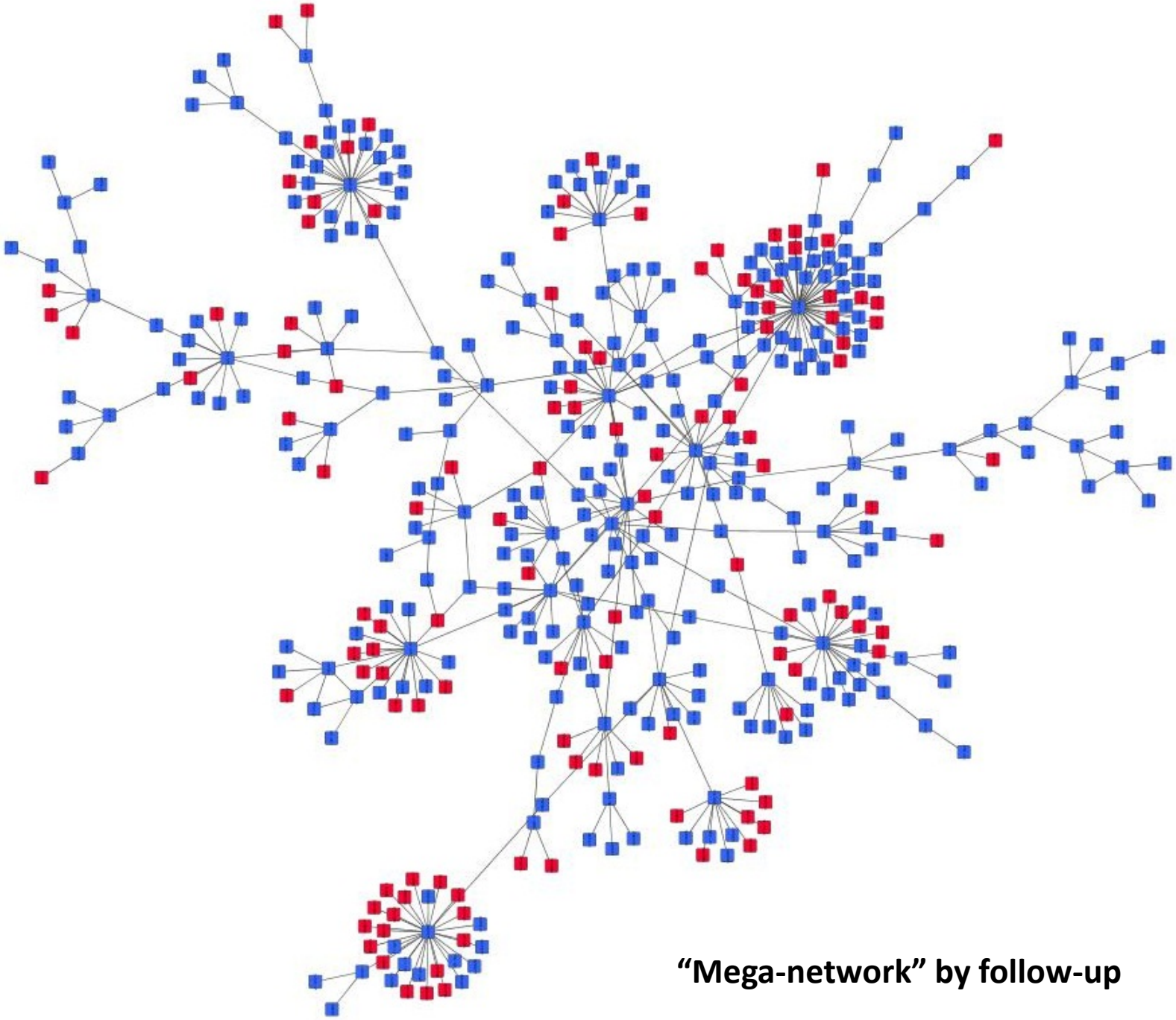
“Mega-network”



“Mega-network” by condition



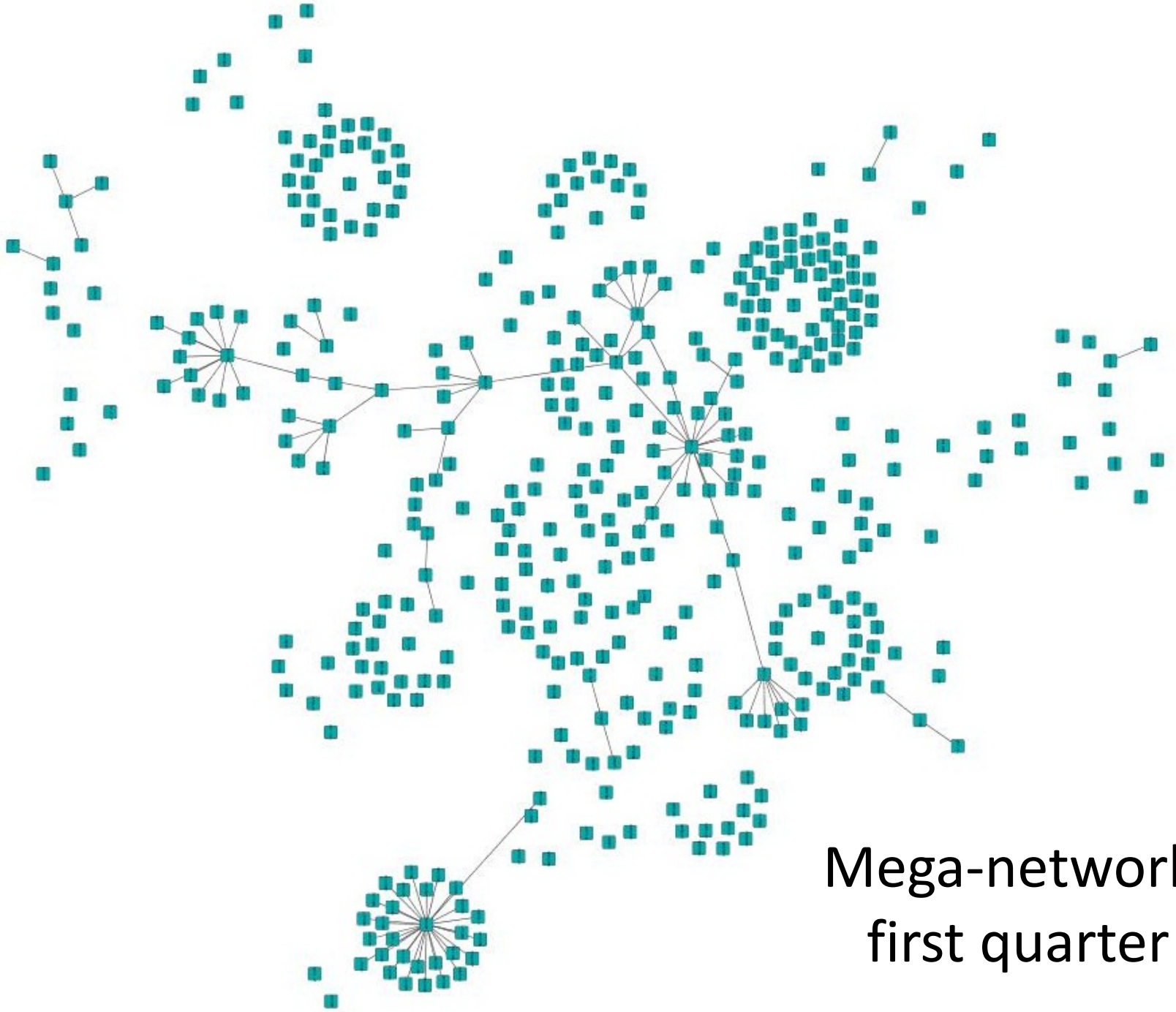
“Mega-network” by HIV status



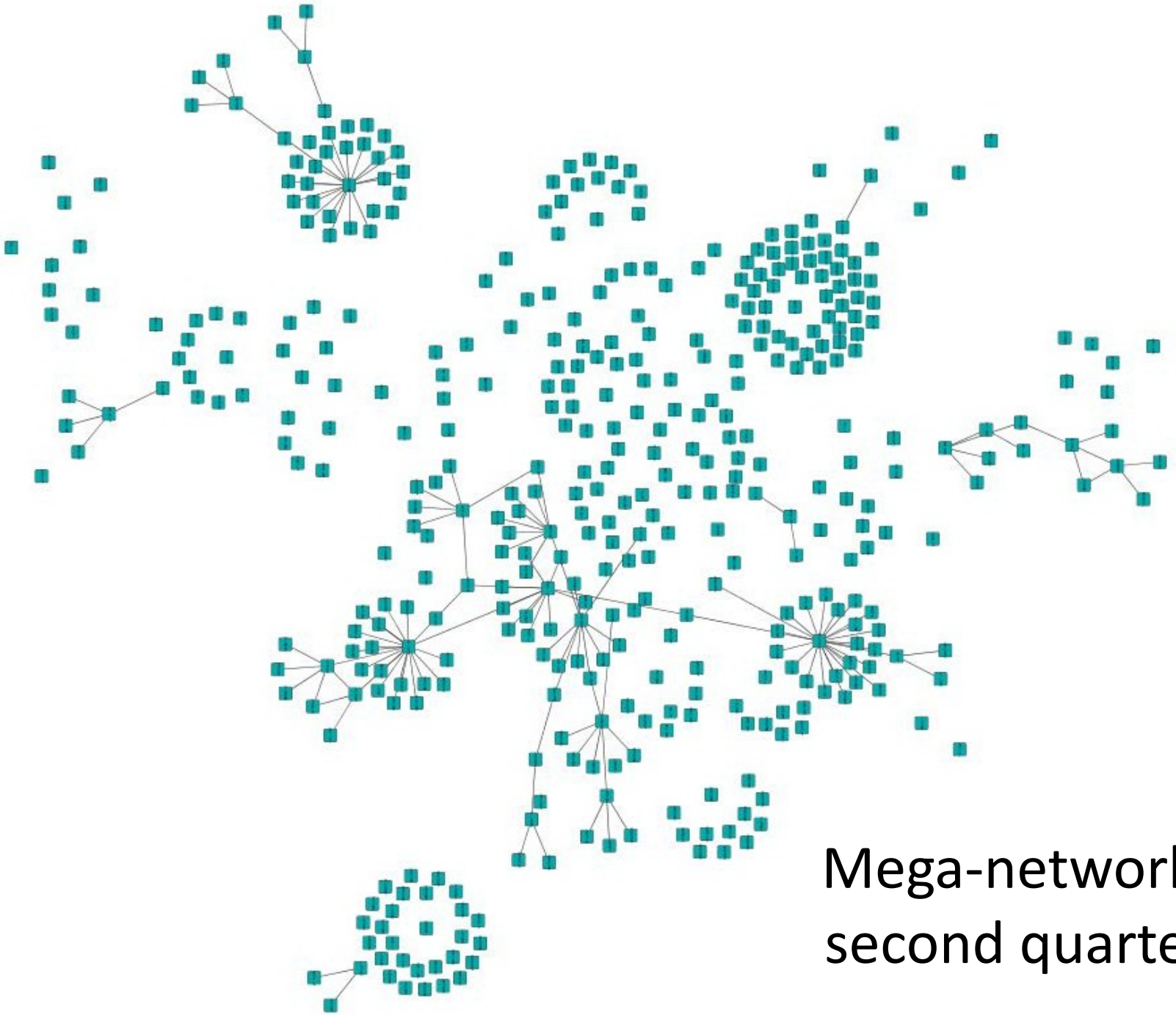
“Mega-network” by follow-up

Network comparisons

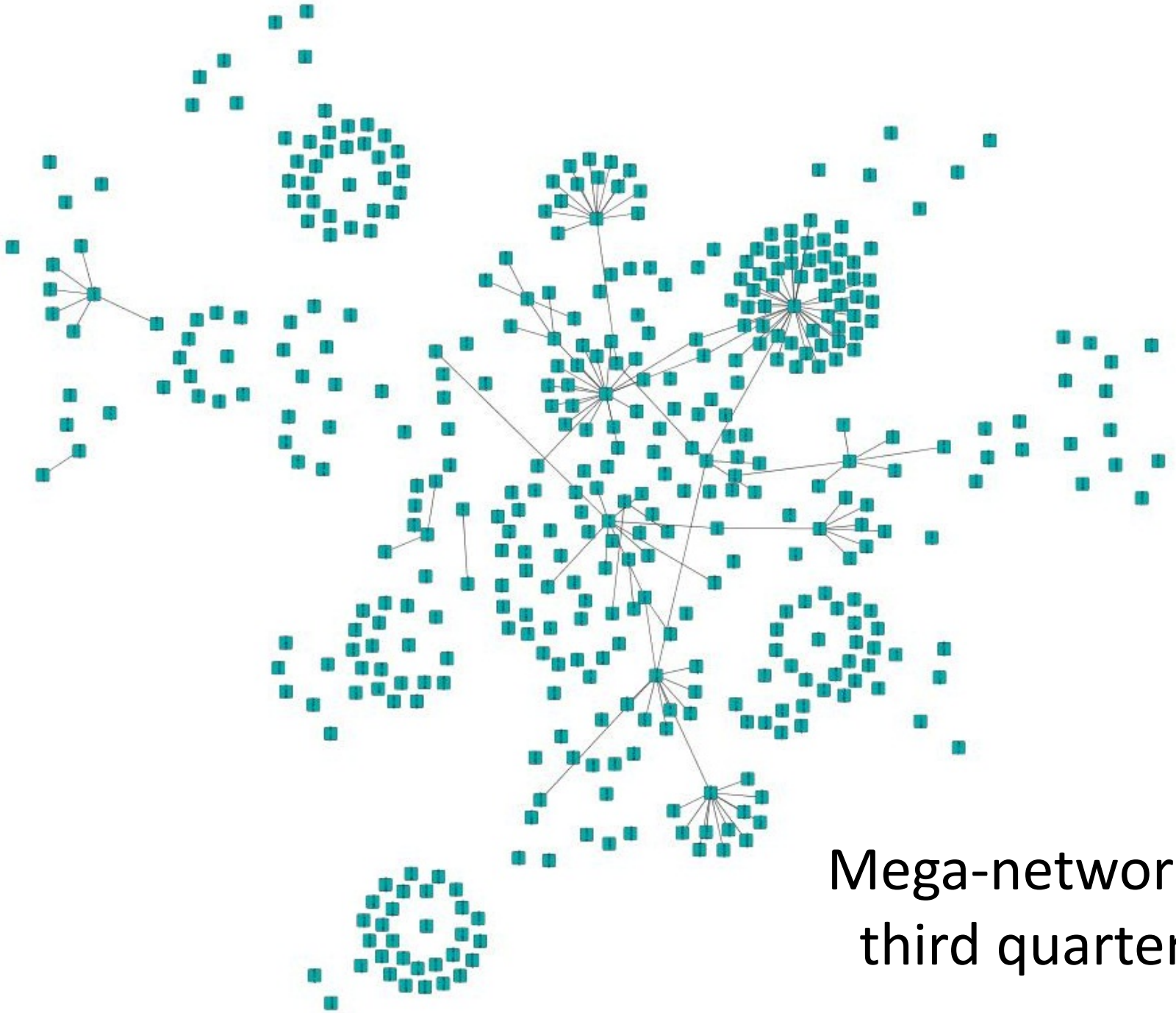
- Mega-network more likely to be HIV-positive than those in other networks (72 percent versus 48 percent; $p < 0.001$)
- Mega-network had more previous syphilis diagnoses reported to us (0.83 per case) than those in other networks (0.62 per case; $p < 0.001$)
- How meaningful are these comparisons?
  - Proportions of cases versus contacts
  - Length of time to define network



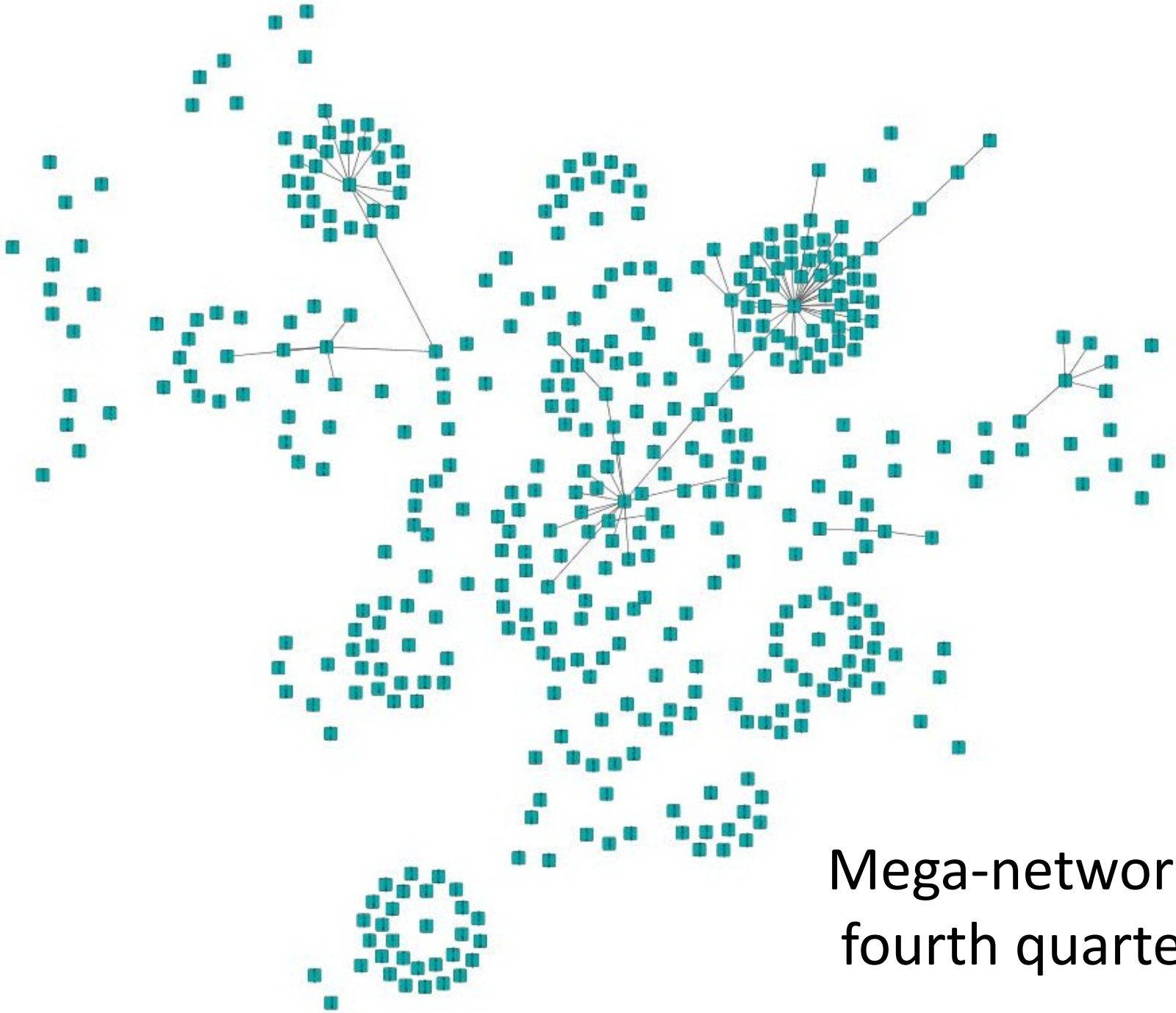
Mega-network:
first quarter



Mega-network:
second quarter



Mega-network:
third quarter



Mega-network:
fourth quarter

Bigger networks

- Using partners elicited in 2012 and 2013, we find a network of 998 individuals
- Using all the data we have ever recorded, going back to 1997:
  - 11,551 persons interviewed or named
  - 6,408 of them can be connected
- Is this a network? Are these core transmitters?

Concluding thoughts

- Our system has produced a rich set of data
- Our algorithm can quickly identify networks
- Need to determine the length of time for a meaningful network
  - Potential for transmission
  - Likelihood of future contact
- More sophisticated network measures may help us prioritize cases and identify likely unnamed partners in real time

Acknowledgements

Brandon Ivory
Charles Fann
Desmond Miller
Erin Antunez
Gloria Calero
Hanna Hjord
Hannah Sabet
James McMaster
Joseph Imbriani
Luis Hernandez
Matthew Sachs
Monica Lee
Rebecca Shaw
Sam Samuelson
Sharon Penn
Tony Tran
Wendy Wolf
Andrew Reynolds
Frank Strona

Thank you!